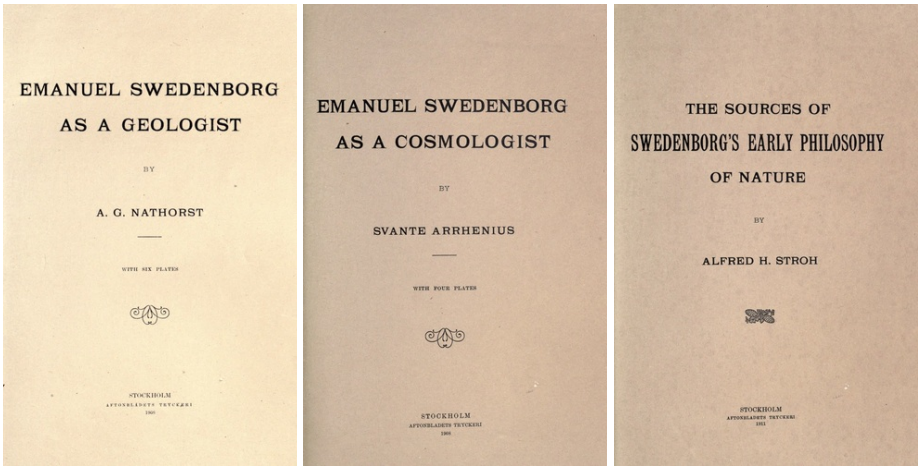

Emanuel Swedenborg as a Scientist.

Miscellaneous Contributions

Preface to the electronic edition.

This work has been digitized in January 2007 from University of California Libraries by Internet Archive and adapted to Project Runeberg in December 2014 by Ralph E.

It seems to be one part missing in this collection, part 2, p 49-56 or perhaps wrong in the pagination.

EMANUEL SWEDENBORG

AS A SCIENTIST

MISCELLANEOUS CONTRIBUTIONS

ED1TED BY

ALFRED H. STROH

«

STOCKHOLM

AVTONBLADETS TRYCKERI 1908

PREFACE.

Although much has been published by Swedenborg's biographers and others concerning his contributions to science, there is still lacking a thorough treatment of Swedenborg's observations and theories comprised in a single volume or series and prepared by specialists. To supply this want it occurred to the editor when preparing the English translation of Professor A. G. Nathorst's »Emanuel Swedenborg as a Geologist» that it would suitably form the first section of a series of papers on »Emanuel Swedenborg as a Scientist». With the consent of the Swedenborg Committee of the Royal Swedish Academy of Sciences, which is publishing a series of

Swedenborg's chief scientific works, it will be possible to publish the papers section by section, including not only the Introductions of the Royal Academy's series of volumes, but also other valuable memoirs. There will be included in section 2 a short contribution by the mineralogist Professor Hjalmar Sjögren, and in folio wing sections reviews of Swedenborg's contributions to cosmology by Professor Magnus Nyrén and Professor Svante Arrhenius.

Stockholm, March, 1908.

Editor.

*EMANUEL SWEDENBORG AS A GEOLOGIST

A. G. NATHORST

WITH SIX PLATEii

t

STOCKHOLM

iFTOXBLiOKTS TKYCtHRlEMANUEL SWEDENBORG AS A GEOLOGIST*

BY A. G. NATHORST.

Although geolog}' as an independent science is regarded as having been first founded by Werner, nevertheless, as is known, tliere were many investigators long before him, who with interest and success applied themselves to the study of the geological phenomena and also made attempts to interpret the same. In this connection Sweden may be proud of having bad among other sucli pioneers men like Swedenborg, Lin-naeus and Torbf.rn Bergman, of whom the last two, as I have shown in another place,1 exercised a direct influence on Werner's system. That the contributions of Swedenborg and Linnaeus in the geological field have been less valned than they deserve, is withont doubt due to this, that their fame in other fields was so great, that what they produced in geo-logy in comparison therewith seems relatively unimportant and has there-fore been mucli overlooked. Besides this, it may be added that their geological observations and statements are in great part scattered in writ-ings whose contents are mainly of a different kind, for which reason it has not been possible to obtain a complete picture of their activity in the field referred to. And still it may be said without exaggeration, that what they produced in this field is of such importance, that it would have been sufficient to secure for them a respected scientific name.

* Translated by Alfred H. Stkoh from the original Swedish in Geol. Fören. För-handl. No. 243. Bd. 28. Hiift 5, pp. 357—400, Stockholm, 1906, and now reprinted in revised form, with a few alterations and additions by the author, from the Introduction to Vol. I. of the edition of Swedenborg's scientific texts now being published by the Royal Swedish Academy of Sciences at Stockholm: Emanuel Swedenborg, Opera quae-dam aut inedita aut obsoleta de rebus naturalibus, nunc edita sub auspiciis Regiae Aca-demiae Scientiarum Suecicae, I., Geologica et Epistolae, praefatus est Gustaf Retzius, introductionem adiunxit Alfred G. Nathorst, edidit Alfred H. Stroh. Holmiae, ex officin a Aftonbladet, 1907.

1 A. G. Nathorst: Jordens Historia. Stockholm, 1894; the chapter on »Geological Investigation in Sweden», p. 34 et seqq. Reprinted in Sveriges Geologi, p. 1 et seqq. See also A. G. Nathorst: Carl von Linné såsom Geolog, in Carl von Linnés betydelse såsom naturforskare och läkare. Skildringar utgifna af Kungl. Vetenskapsakademien. Uppsala och Stockholm, 1907.In studvinir Swedenborg's contributions in the held of geology \ve must admire the many-sidedness and the sharp powers of observation to which tliey bear witness. Although I have endeavored to confine myself to his purely geological and paleontological contributions, ncvertheless liydrographical problems, together with questions of a Chemical and phv-sical nature, have also been touched upon, when they have had to do with geological questions. For geology comes into contact with so manv different Sciences that this could not possibly he avoided.

In giving an account of Swedenborg's contributions in various geological departments, it will be most suitable,

in order to obtain a general view, to treat the various questions by themselves, rather than to follow the chronological order of his writings. For he returns to the same subject in so many different places that the chronological sequence in many cases is not suitable for the production of a.complete picture of his treat-ment of one and the same question. A beginning may liere bo hest made with that question in this department with which he First busied himself, and to which he often returns with predilection.

Proofs for a higher water-level in former times.

To begin with it should be remembered that a long dispute had been going on for several hundred years before Swedenboro's time concern-ing the interpretation of the fossils occurring in the rocks, about which the most fantastic opinions had been expressed. Leonardo da Yinci had alreadv understood their true nature, and the same view was subsequently maintained by Fracastoro (1517), Palissy (1580), Steno (1609), Leibniz (1680), and others. And when it could no longer be denied that the fossils were the remnants of organic forms, there were those who maintained that they were deposited in the places where they are now found during the »universal flood»1 (Noah's flood, »syndafloden»).

Swedenborg certainly did not doubt that this inundation extended over the whole earth, and it would seem as if in his first work on the subject in question^)2, Om Watnens llögd och Förra Werldens starcka Ebb och Flod. Bewjs utur Swergie. Stockholm, 1719, (On the Height °f Water and the Strong Tides in the Primeval World. Proofs from Swedeii),!i

' »Flood» here means the same as inundation.

* The numbers in small black type refer to the pages in Vol. I. of Kummel Stre-denborg: Opera quaedam, etc., Stockholm, 1907.

3 An English translation of this treatise, as well as of all the other shorterlie still supposed that the testimonies brouglit forward b}*- him for a liigher water-level in former times refer to the same llood. I11 the dedication to ririca Eleonora3 he indeed only savs that he wislies to furnish some ncw prool's that Sweden in former davs had been covered by water and that on aceount of the abatement of the water it subsecpiently became larger and larger, even up to the present time of the Queen's reign. In the preface5, on the other hånd, he starts out from the biblical aceount and takes his point of departure in his treatise witli this, that although no one denies that the universal flood has stood over the earth, nevertheless worldly wisdom also wislies to have a word to sav in the matter, and thcrefore slie investigates and gathers proofs from the things which the llood has left behind. In but two places in the work itself is the universal llood of the Bible again mentioned, and only two vears later he expres-ses56 in his letter to Jacob a Melle, which will be mentioned further on, his doubts as to how far all the facts brouglit forward refer to the above mentioned flood, which indeed, says Swedexborg, lasted but one year.

As concerns the fossils, Swedexborg seems from the very beginning

to have clearly understood tlieir real nature, which indeed was at that

time almost generally acknowledged. But as an independent geological science was not then in existence, tliere was not vet any idea about the respective ages of the fossils, and the facts brouglit forward by Swedexborg, which demonstrate a liigher water-level in former times, are in rea-lity in relation to one another of as different ages as tliey could possibly be, for some come from the silurian, otliers from the glacial and postglacial periods.

If from the modern standpoint we attempt to analyse the proofs

mentioned by Swedexborg, we tind, as is natural, tliat some of them

cannot be regarded as valid, wliile on the other hånd otliers are still valid. Thus7, when he wislies to conclude from the position of Kinnekulle between Hunneberg and Billingen that Kinnekulle arose through the deposition of the strata in a calm water between the mountains mentioned, he has certainlv failed to see tliat tliese were in realitv formed at the same time as Kinnekulle and did not exist before it. On the other hånd, he is on the right track when he points to the different horisontal strata, of which Kinnekulle consistss, as proofs that they were

deposited in water.

geological coutributions by Swedexborg, may be consulted in Part I. of Scientific and Philoaophical Treatises by Emanuel Swedenborg, edited by Alfred H. Stroh, and pub-lished by the Swedenborg Scientific Association, Bryn Athyn, Pennsylvania, 190fi—1908.In order to explain the extension of the »åsar» from nortli to south®, to which Eric Benzelius had called his attention, he advances two alternative interpretations. According to the one it is supposed that the »åsar» were thrown up, by the tidal waves, a t the time when the sea stood over the whole land, and were thus deposited parallel witli them; according to the other interpretation it is supposed that the cause was the winds, continually blowiug in an east to west or in the contrary direction, in aualogy with the present trade winds.

Although we now know that the »åsar» were not formed in the ocean, vet as late as 1868 they were supposed by A. Erdmann to be raised beaches. The verv constitution of the »åsar», in part of sand11, in part of shingle, together with the rounded and ground form12 of the stones in the latter case, is further brought forward as a proof of their formation in the water. The mountains of limestone also bear witness, partly by their formation of laver on layer and, partly by the inclusion of animal remains in the stone, »that they [the limestone mountains] were an oceanic mud and a refuse».

Neither was the phenomenon of the erratics unnoticed. In regard to the question of the presence in the »åsar» of rounded stones it is consequently advanced,18 that stones of widely different kinds, one car-ried thither from one quarter, another from another quarter, are there met together. Attention is further called to the large erratics which are often found many miles from their original cliffs. Swedenborg supposes that these stones were removed by the help of the water; he first describ-es the loosening of the stones from the mountains11, which would be actively advanced if the tides were strong, so that the rocks would at one time lie dry, exposed to the sun’s heat, at another time covered by water. Pieces from the rock could in this way have been loosened and afterwards been carried awa}r by the waves. In a special chapter attention is called to the power of water in strong motion to move blocks of stone, especially when the water is salt, (for then the stones lose more of their weight), and when the mass of water in motion is deep.1 In this manner Swedenborg endea vors to explain13 why widely extended regions are covered »bv large stones rolled on one another», »strewn about like sand», »cast up into heights and hiils», and so forth.

Swedenborg also believed that he miglit bring forward as a proof of

See also the special discussion of this question in Swkdknbokg’s Eepositio Legis Jlgdrustatkae, ete.u liigher waterlevel in former times10 what he called »water-lines» on Hunneberg and Billingen, which are said to be as horizontal as if they had been drawn according to a level, so that if the ocean should rise to this lieiglit its surface would follow the border referred to round about the mountain. »Above this line of division tliere is a greystone mountain [trap verv steep like a wall, underneath a declivity consisting of stones and rocks which are loosened from the mountain. Here one can actually observe the height of the water, where it has for a time remained stationary, and marked the place where its edge was, having also pushed ont stones and made the ridge perpendicular». Swedenborg evidently believed that he had noticed what in later times have been called shore-lines, but from the description it is plain that the border-lines between the trap and the underlying sedimentary strata are in question. He himself savs this in another place70: »tliere is a horizontal line of division (»divisio») on the lower side, namely, between the greystone [the trap] and the underlying limestones and slates, just as if it had arisen with the lielp of water along a shore».

From the circumstance that the land and mountains are built up of many different strata17, as at Helsingborg, in the Vestrogothia mountains, and so forth, it may be concluded that the}r were deposited in the sea, which is furthermore proved by this, that the water has hidden in these strata »heaps of fislies, snails, and otlier shell-bearing animals, and, in order to better preserve them against time has petrified them».

Giant-kettles are also brought forwardls as proofs of the former liigher water level, and their origin is connected with vortical movements in the water when being moved by strong tides, »and if stones have happened to lodge

in these whirl-pools they have been carried around and ground against the sides and tlius widened the hole more and more». Cases of such giant-kettles at Gullmarsberg and Strömstad are referred to, (several being mentioned, one of them with a large heap of round and polished stones), and there are also cases in Lapland, according to Olof Rudbeck, junior. Three giant-kettles at Trollhättan, many fathoms liigher than the present surface of the river, show that the river has cut down deeper in its bed.

A very clear proof of »the former world's tides» are the banks of sliclls in Bohusliin1", as at Uddevalla, between Strömstad and Sundsborg, on the islands Orust and Tjörn. Those at Uddevalla are reported as lying 50 fathoms above the sea-level, and the manner in which they are stratified makes it clear, savs Swedenborg, that they were gathered bywirnl and wave, or by the tides. In another place*1 it is mentioned tliat banks of shells (»musselsteen») of the same sort mav also be found at Addetorp, in the parish of Tunhem.

But not only the banks of shells, but also20 »other marine animals, swimming creatures and wonderful insects», even fish[?], which are found enclosed in the stone, especially [silurian] limestone and slate, and which are themselves turned into stone, afford proofs of the universal flood, sincc stone and slate have been nothing else »than mud, sediment, clay and sand». The présence of sucli organisms is alleged to occur in various places in. Vestrogothia (Skarcke parish, stora Dahla, and especially in Billingen), even as many as twelve Swedish miles from the sea. In another place31 some other localities are also refered to, (Höjentorp, Öglunda church), and it is added that small mussels are also found together with the rest. I11 discussing tliese petrifieations Swedenboeg men-tions that Professor Bromell possesses a large collection of them, which he (Bromell) intended to describe soond

It is further reported20 that remnants of the wrecks of ships have been found at some places far inland, and even liere is found the report of iron rings in the mountains far from the present shores, which would be useful for fastening vessels. These accounts have as is known survi ved even to the most recent times, although no investigator has ever been so fortunate as to himself discover sucli a ring. However, Swedenborg draws the conclusion from the evidence brought forward »tliat Sweden mav in former times have been an island or an lltirna Thule. as the poets say».

What Swedenborg reports21 concerning the remnants of bones of the wliale, which was subsequently called the Swedenborgian whale, is of sucli great interest that it may be referred to at somewhat greater lengtli. Some years before, (see below), in Yånga parish, two Swedish miles from Skara and twelve miles from the West Coast, there had been »found a ske-leton consisting of leg bones, vertebrae, etc. Had the skuil been there the remains might have been taken for those of a Swedish Polyphemus or Cyclops, who once forged the weapons of Vulcan for our Mars, or some other one of the Gotliic heroes or warriors». The skeleton was taken to l psala and there put together, when it was found tliat it had belouged to a whale, which had gone far inland when the

1 The allusion is tu Bkomkll's was publishe«! in 1727.

»Lithographiæ suecanæ specinien secumhum, whichwater stood high, but liad to remain when the water decreased. »It is still in tlie Upsala museum in the care of Professor Doctor Roberg, and serves as a monument to the universal fiood and the overflowing of the great ocean over Europé».

From a letter from Dr. Johan Moraeus (subsequeiitlv the father-in-law of Linnaeus) to Eric Benzelius (Swedenborg's brother-i 11-law), dated Brunsbo, (the episeopal residence near Skara). Xov. 21, 1705, which letter is referred to by Lilljeborg, it appears that the find was made shortlv before, for at that time all of the bones were not yet dug up. Åccord-ing to Carl Aurivillius1, the place where the find was made lies about 152 kilometers from the coast and 100 meters above the sea2. Moraeus savs in his letter that the bones would be taken to the Skara cathedral. Whether this occurred is uncertain.

In any event it appears that it was due to Sweoenborg that the hones were taken to Upsala, for in a letter301 from him to Benzelius, dated Brunsbo, March (J, 1710, we read: »Four or fivc weeks ago the bones of a giant were sent from liere; I suppose they have arri ved, wliicli I also desire, because I alluded to tliem in some verses,

which Magister Unge will perhaps introduce into his dissertation; tliey are as foliows:

Smit Gothia nuper spatiösa meinbra giguntis Aveda, ast eerebro, ast ingeniogne careiit. Fertilis haec tellus alium nutic mittit ahunnmn. Yirilms i ngeni i hic, corporis ilte, ralet*

For this reason 1 wisli that the bones may not be delayed on the way; the novitiate who took them witli him seemed to be well disposed.

1 Carl Auuivillivs: Der Wal Svedenborg's (Balaena Swedenborgii Lilljeborg) muh einem Funde im Diluvium Schwedens beurtlieilt. K. Svenska Vetensk. Akad. Handlingar Bd. 23, No. 1. Stockholm, 1888.

- Cf. H. Ml.vthe's more complete aecount in the contribution »Um faunan i Yest-götaslättens yoldialera . Geol. Foren. Forhandl. 23 (1901): 120, from which it is clear that the height, determined more exactly, is 97 m. The place where the tind was made is also mentioned and illnstrated by the same autlior in the description for the chart »Falköping». S. (i. U., Ser. Aa, No. 120, 190G.

:1 In a free translation, as given in R. L. Tafel s »Doeuments coftcerning Sweden-borg , London, 1875—1877:

From Gothia came a giant's bnlky frame;

But brains and quickening intellect it lacked.

This fertile land a new alumnus sends;

In mind gigantic this, as huge in body that.From this letter and from the verses1 it is clear that Swedenborg tlien really believed that the bones came from a giant, and it is therefore unlikelv. as Carl Aurivillius supposes, that it was Swedenborg who first nnderstood that a whale was in question, but the merit of doing this is apparently due to Lars Roberg, Professor of Anatomy and Practical Medicine at Upsala. Indeed it is clear from Swedenborg's own statement that it was from a doser examination of the bones after their removal to Upsala that their real nature became evident.

Sven Nilsson appears to have understood long ago, (Skandinav. Fauna 1S47), that a species of whale different from the Greenland whale was in question. In 18(>2 Lilljeborg called it »the Swedenborgian whale», and subsequently gave it the narae Hunterius Sicedenboryii. Carl Ar ri-vi llius, who in 1X8S (1. c.) described a more complete skeleton of the same species, found the year before in the glacial clay in the parisli of Tvååker, Halland, about 5.5 km. from the coast and 15 m. above the sea, refers it to the genus Balaena. and endeavors to show that it was identical with or nearly related to the »south-ice-fish», living at Spitzbergen in the beginning of the eighteenth century, so named to distinguish it from the real Greenland whale, the »west-ice-fish».

Furthermore21, when Swedenborg explains the inland seas with their fishes as relics from the former covering of water, the series of thought is of quite the same kind as that which in later times led to the expla-nation of the relict fauna in our great seas. He emphasizes the statement that even at Hunneberg and Billingen there are found fishes in the lakes »which are all of the same kind as those found in the sea itself»., and he does not understand how the fishes could have gonc thither if they were not left behind by the sea. It is however evident that Swedenborg liere had in mind the fishes which are found in the I »altic, for naturally no identity with the fisli fauna of the North Sea can have been in question.

It is further advanced23 that the streams in the vallevs have cut

*/

down deeper in the degrec tliat the water has decreased, wherefore dried up or deeply cut streams in vallevs furnish proofs of the liigher position ol the water in former times. M hy he supposed that the black soil was a proof ol the same has not become clear to me; he liere supports him-self by Olof Rudbeck, Senior. The uneven topographical configuration

1 1 he verses by Swedenborg, it may be added, were publislied by Unge in his dissertation: D'mertatio theologica de Consummatiom Mundi... Sub. Praesidio Dn. Jo-hannis Pahnroot... submittit Andreas Unge... 2 Apr. 1710.

Upsaliae, 1710.in our county is advanced'24 as a testimony pointiug in the same direc-tion, by wbich Swedenborg appears to mean tbat the water worked partly as an eroding force, as well as an accumulating force, forming banks of sand and gravel in other places.1 Finally, the annual descent of tlie Baltie is advanced as a testimony tliat the sea-level was formerly liigher than now. It is here advanced that this descent takes place so rapidly tliat where tliere were formerly good fishing places fields and meadovvs are now found; that the towns in Lapland had to be moved down; that the harbors and passage-ways for sliips used in former times have had to be reestablished; tliat former staple-cities now lie far inland, even as far as 7 Swedish miles, (Upsala being referred to by way of example). According to Berzelius2 Swedenborg was the lirst to call attention in a printed work to the decrease of the water in the Baltic (»the rising of the Scandinavian coast»), but in this respect, as no doubt in various other matters, he had a predecessor in Urban IIjärne.

In a chapter on the change of the northern horizon'2-’ Swedenborg expresses the view tliat if the seas of the world rise towards the soutli, or at least sink tliere less than in the northern tracts, the earth’s form would be changed, in tliat it would become flatter at the poles and

rounder at the ecjuator, so tliat if the earth’s horizon was formerlv of

---------- _ <

1 In the introduction to his great work on Copper Swedenborg also expresses himself concerning the flood, as Mr. Strou has pointed out to me. The uneveness of the earth’s surface is ascribed to the flood. Savs Swedenborg: >We incline to think, indeed it cannot be questioned, tliat onr planet was perfect in beautv, delicious in variety, and like one vast paradise, before the flood; its surface unbroken and even, with no precipitous mountains or rugged rocks, no deep vallies, no lakes, and no seas: hut that after the flood this order was reversed; that it changed its estate, and its surface became broken and uneven, from its outer crust being rent asunder by the waters.» {The Principia, by Emanuel Swedenborg, transi. hy Clissold, Vol. IL, London, 1816. See page 378).

As to the manner in whicli this took place, according to Swedexrorg’s view, the original may be consulted. Here it need onlv be mentioned tliat he supposed the mile-thick earth’s crust to have rested upon the water, a supposition whicli is also found, at least in part, in the writings of Urban IIjärne, Athanasius Iyirchee, J. J. Becker, and otliers. Perhaps the biblical aecount of the flood, that »then were all the fountains of the great deep broken up», was not witliout influence upon Swedenborg’s conception. This transformation was also, according to Swedenborg’s view, of importance for the origin of mineral deposits, concerning whicli he who is interested will lind detailed information in the original.

2 J. Berzelius: Några ord om den skandinaviska vallens höjning öfver ytan af omkringliggande haf och om afslipningen och refflingen af dess berg. Forhandl, vid de skandinav, naturforskarnes tredje möte i Stockholm den 13—19 juli 1812.Mii oval shape it would now become more and more round. On account of tlie couscquent change of tlie meridians tlie size of a degree in our traets would be diminished, so that wliere it formerly was for exainple 10 Swedisb miles it would now perliaps be little more tlian 0. The cause might lie in this, that tlie eartli formerlv rotated more rapidly than now, wliich would also bring witli it a shorter time for the revolution of the moon. This would result in a higher level of the water at the poles, for if tliere were only 2 or 3 hours between the tidal waves, instead of (3, the water would not be able to return to its normal niveau before it would be inrtuenced anew by the moon’s attraction. In this manner tlie sea at the poles would have been kept higher, but would subsequently, in the degree that the motion of the eartli and moon decreased, gradually fali, wliich is proved by the descent of the water in the Baltic and by what is reported of its ascent in more Southern traets.

Now, if Sweden was formerly covered by water, wliich subsequently decreased, the highest parts have formed an island-6, as was supposed by Rudbeck, Senior, and the geographers of former times. By means of leveling olie niav determine wliich part of the land is the highest, and wliich therefore fornierly, when the water stood higher, must have been an island. In this conneetion Swedenborg remarks that it would be of interest to learn what the height of the Baltic is in relation to tlie sea at the West Coast.

That the tides must have been stronger when the water completely covered the land is evident27. Afterwards tliere was liere formed first an archipelago of larger and smaller islands, then, in the degree that the mainland was inereased, the tidal phenomenon could no longer make itself valid in the same ilegree as before. The concluding words of the work under consideration must be reproduced verbat i m:

Trom the reasons advanced it may doubtlessly be concluded that our eartli has had a high sea and a dood over itself; that the tops of our highest mountains and bilis were under its level and have inereased and as it were built themselves up under the water. It may also be concluded from the proofs that the sea rose espccially above our North, wliere it had its highest level and as it were caused the greater rotundity ot the eartli, wliich was to be seen in a higher degree then than now; and that Neptune, witli all his Sea-godesses and Nymplis, as it were enjoyed remaining liere as long as possible, and then gradually departed and lelt his abyss for us to live and build on, thus enlarging the land o! Tvea up to the time of the present government,»As is manifest from this presentation, Swedenborg supposes that the descent of the water took place little by little and gradually, although ho still appoars to connect the higher water-level with the universal flood. But not long after this work he expressed himself very clcarly against the view that all the testimonies advanced to show a higher water-level in former times are connected with the universal flood. This occurred in his letter to Jacob a Melle'*, dated Stockholm, May 21, 1721, which was directly occasioned by v Melle's work on petrifications (figured stones) in the environs of Lubeck1, in which Swedenborg's work On tlie Ileiyht of Water, etc. is cited. By way of introduction it is advanced in the letter that petrifications occur in vafious parts of Sweden, as also that collections of such petrifications have heen made by the Provincial Phvsician Johan Hesselius, the Assessor Dr. Magnus von Bromell (who has also had them engraved on copper)2, and also by the Professor of Medicine L. Boberg in Upsala. Swedenborg then passes over to the proofs, which, according to his view, are at band to show that the land was formerlv covered by the ocean (the same proofs which were advanced in his treatise). But liere there is appended the weighty addition. that not all the facts advanced could relate to Noali's flood, which indeed lasted only one year. Especially is this valid concerning the changes which have taken place since Sweden was settled, etc. »These circumstances indicate that not all the events under consideration took jdace during the universal fiood, but that the carth and especially its nort hern tracts were for a long time afterwards covered by a deep sea, out of which they little by little arose in the degree tliat the water in the northern tracts decreased, or in other words the foundations became inhahitahle».

It may liere he observed that a summary, »similar to the one in the letter to Jacob v Melle, although in some points more extended, was also presented in the first chapter of the »Prodrontus Principiorum»3, published in the autumn of the same year (1721). In it strata of salt or whole mountains of salt are explained as having heen deposited on the bottom of the sea at the time when the ocean covered the earth. In this work also it is expressiv stated that not all of the testimonies

1 I)e lapidibus figuratis agri litorisque lubecensis. Lubecæ 1720.

3 The illustrations for Bromkli.'s »Lithographiæ snecanae speciinen secunduni», published subsequently (1727), are here referred to.

s The complete titles of the worlcs by Swedenborg here cited are given at pagea 10—41.advanced to show ti »c higher water-level of the ocean in former times can be referred to the universal tlood.

The iirst chapter (Observata circa montium diversitatem in Sueeia, ot disquisitio de illorum origine) in Swedenborg's »Miscellanea observata circa res naturales» taken as a whole contains08 the same views, as concerns the mountains, (although here the strata of the mountains in Osti •ogothia and in Gothland are also mentioned), and erratics are referred to in the treatise On the Height of Water, etc. The position, nature and characteristics of the mountains are regarded as being results of the universal flood. The presence of the great erratics, like fragments of mountains, even in regions where no mountains exist, indeed on the tops of other mountains, is especially emphasized. That the erratics, according to Swedexborg's view, are especially found at places situated very high above the sea, as in the tract of Örebro, he considers to depend upon this, that the water

there was not so deep and therefore did not possess the power to move the blocks further. Another chapter (Observatio circa subsidentiam marium versus Septentrionem) in this work (Miscellanea Observata) also contains** a summary of what was advanced concerning the subject in question in the treatise On the Height of Water. It is here reported that hooks and other objects for fastening vessels have been found especially in Upland, and it is here further emphasized that not all the changes in the earth's erust have been caused by the universal flood, but that some have been occasioned by this, that the sea was formerly considerably1 higher than now, and at that time certain lavers with the petrifications enclosed in them were formed, while on the other hånd others are derived from the universal flood. It is also expressiv stated here that the surface of the Baltic is higher than that of the North Sea, as shown by the faet that the descent of the streams which flow to the North Sea from the highly situated region at Örebro is by calculation found to be greater than for those which flow to the Baltic.2 Therefore the latter's diminished height as observed in the

1 In reality it should have been said that the shore-lines were formerly several miles farther inland than now, hecause this is evidently Swedkxbohg's view. Hesavs: Non omnes mutationes in terrae erusta a diluvio universali örtum suum duxisse, sed etiam a mari supra horizontem hodiernum multis parasangis olim exstanti», etc. A parasang or ancient Persi an mile corresponds to 30 stadia or 4.5 kilometers. Of course fewEDEMioiu; could not liave meant that the difference in the sea-level s vertical height was many parasangs.

As a matter of faet actual measurements had not been made, but Swedenborg says that the descent to the North Sea would be about 70 ells.north may depend upon its outflow into the North Sea, a view which later on is repeated by Nordenanckar.

The proofs of a higher water-level in former times advanced by Swedenborg which have been reviewed above are all taken from Sweden, except what he says concerning tlie formation of strata of salt. Bot in the »Miscellanea Observata» he devotes a couple of chapters to the con-ditions on the continent, which in his opinion furnish testimonies pointing in the same direction.

One of these (Observatio de vegetabilibus petrificatis Leodii07) treats of the presence of plant-fossils in a mountain near the cloister Chartreux near Liége in Belgium. Swedenborg considers that the constitution of the strata and the fossils enclosed in them demonstrate that the ocean formerly stood at least a hundred ells (60 m.) above the present sea-level, and so he supposes that the land with its plants was laid waste, the plants being imbedded in the sand and clay. I shall further on return to the plant-fossils, which belong to the coal measures, and of which figur es are given in this connection. The second chapter, which is referred to above, (Observatio de stratis ex conchilibus Aquisgrani68), treats of the fossiliferous strata at Lousberg near Aix-la-Chapelle, which according to Swedenborg's estimation is situated hardly a hundred elLs (60 m.) above the sea-level. In giving an account of the mountain he says that more than ten of its various strata are formed by the shells of molluscs, heaped up in such quantities that whole wagon loads of them might be gathered. From the constitution of the strata and fossils he draws the conclusion that they have undergone some change by the influence of water and heat since they were deposited. In passing he refers to the banks of shells in Bohuslän as a formation similar to these fossiliferous strata, and on account of the presence of the fossils lie comes to the conclusion that the ocean at Aix-la-Chapelle formerly stood at about the heiglit of a hundred ells (60 m.). Swedenborg gives figures of some fossils collected at Lousberg, which, as we now know, belong to the cretaceous formation. I shall return to these also further on.

The trap in the mountains of Vestrogothia.

As early as 1719, in his treatisc On the Heiglit of Water, etc., in a special chapter, (On the strata of greystone on top of limestone18), Swe-Denborg expresses the opinion that the »greystone» which covers the limestone at both Kinnekulle and Billingen, in which »fishes and insects are concealed», must also have been deposited in the sea as »a finesediment and mud . . . although in it there ure never anv animals to >>e found, as in ot her strata». At this time, when there was no knowledge of volcanic mass eruption, the conclusion was quite natural; it is indeed the same conception whicli was long after accepted by the school of Werner in connection with basalt.

Swedenborg returns to the same subject in the »Miscellanea obser-vata , where a special chapter70 (Observata circa strata duriora, constantia Saxo communi Griseo; deque illorum origine) is also devoted to the question. Ile expresses his astonishment that greystone1 in many places is found in stratifled kinds of rock, although it usually builds up moun-tain chains, as in the Alps and many of the mountains in the North, which are generally considered as being synchronous with the earth itself. But that the greystone which is here in question — the trap in the mountains of Vestrogothia — was once soft and like clay, Swedenborg considers, as mentioned above, to be demonstrated by this, that in Killingen, Mösseberg, Hunneberg and Kinnekulle this greystone lics above the fossiliferous strata of limestone and slate, and he remarks that lie has seen the same kind of rock between the strata of clay and slate at Liége and otlier places. In passing it may be remarked that Swedenborg held that the perpendicular walls of the mountains are connected with the cuboidal (columnar) splitting of the trap.

It was apparently not overlooked by Swedenborg that no petrifica-tions were to be found in the trap; on the contrary he endeavored to demonstrate by experiment wbat occasioned this. He considered the trap to be formed of an especiallv fine sediment, which was for a long time loose and flowiiig, on which account the harder objects sank through it, while the lighter ones (plants, etc.) fioated up to the surface, and animals were able to escape from it before it hardened. The demonstration is indeed not successful, but our interest attaches itself to the faet that Swedenborg saw the necessity of trving to explain why the petrifi-

1 It ought to 1 »e pointed out for fore i jr n geologists that in Sweden »gråsten» greystone; does not mean granite alone, but in general a hard crystalline kind of rock, in a sense opposite to the sedimentary rocks, like sandstone, chalk, slate, etc. It is therefore incorrect to translate »saxum griseiun» by granite, as has been done in a number of foreign works. C. E. Strctt, in translating the Miscellanea obser vat a--into English (Miscellaneous observations connected with the pbysical Sciences. London, 1847) himself used »granite» in translating, but in the lntroduction (p. XIV) correctly emphasi/.ed that »the saxum yriseum of our author . . . may generally be considered as representing the various rocks from the granitic to the trgpean formations».cations were missing in the trap, although it was snpposed to have been

deposited at the bottom of the sea, >

On the falling and rising* of Lake Venner.

Swedexborg's manuscript88 on Lake Venner1 has, as is known, been made the subject of a critical examination by Professor R. Sieoer of Vienna (now in Graz) to whose more extended account those who are interested are referred1 2. The matter to be explained was the faet that Lake Venner from time to time rises (or falls) even as much as 0.6—1.8 m. above (or below) its usual niveau. Swedenborg calculated at Rånnnm's Bridge the quantity of water which leaves the Lake through Göta Elf, and in doing this he came to the conclusion, that the quantity was so inconsi-derable in comparison with that of the Lake itself, that if the outlet

were closed up for a wThole year, the rising of Lake Venner caused by

it would amount to only O.is m. If on the other hand the inliow were supposed to be shut off for the same length of time, the sinking of the Lake's surface would not pass beyond the same point, for according

1 Om Wennerns fallande och stigande och huru wida thet härröra kan af watt-nets tillopp eller aflopp igenom strömmar.

2 R. Sieger: Eine hvdrographische Studie Swedenborg's. Nachrichten uber

Geophysik. Bd. I. Wien, 1891. Sieger, who had access to a photolithograpliic facsimile of the original manuscript by Swedexborg which is preserved in Linköping, has not indeed been able to decipher every word and has therefore made one or two mistakes, hut these are of subsidiary significance and have little influence on his work as a whole. I shall here point out that which has caused him the greatest trouble. Swe-dexborg, in the first section of his paper, gives as an exainple of the changes in the height of the water the following: »Strandbonden theromkring wet at berätta, huru han ibland förlorar sin åker och eng; ibland får han stora ypna trader, i thet at jord-mohnen sluttar longsamt», etc. (»The farmer near the shore at that place relätes that he has

sometimes lost his arable lands and meadows; sometimes he receives large open tracts, because the surface of the ground slopes graduallv», etc.) Sieger here read: »ibland får han stora yxan», and although he thought that the indistinct word following »yxan» really was »tracter», he believed that for the sake of the connection it should be interpreted as being »kasta», that is, the meaning should be: »sometimes he may throw the great axe», (»ibland får han stora yxan kasta»), which would mean that the farmer at the shore might sometimes win as much land as corresponded to the throw of an axe. The erroneous interpretation therefore followed from this, that Sieger read »axe» (»yxa») instead of »open» (»ypna»).

In the first portion of § G Sieger has read »vanliga» (»usual») instead of »longliga» (»long») and therefore translated it with »gewöhnlich», and in the last portion of page 123 of the facsimile of the same section he has read »snart» (»soon») instead of »swTårt» (»difficult»).to Swedexborg's supposition tlie quantities of inflowing and outflowing water would correspond to each other. But since Lake Venner during only a few weeks can rise even as much as 0.89 m. Swedexborg supposed that this could not be connected with the inflow or outflow, but must be due to other reasons, and this the more, since other great lakes, like Vetter and Bodensjö, were reported as acting in the same way. He wished to find the reason in a deformation of the Lake's surface, which he considered to be higher at the centre than at the shores. When this difference is equalized, the water is so to speak driven towards the shores, which presents the appearance of a rising of the whole surface of the Lake. The falling would depend upon a movement of the water in the opposite direction.

Swedexborg's calculations, however, as Sieger has shown, do not bear examination. It was of course insufficient to calculate the quantity of water in the outflow at only one single period of the year, and as the calculation seems besides to have been made at a very low water-level, the result was altogether too low. On the other hånd Swedexborg estimated the area of Lake Venner as being from 6 to 7 times greater than it actually is, as being 36558 square kilometers instead of 5568.4. Both of these sources of error strengthened one another. Besides, Swedexborg overlooked sucli weighty factors as rain and snow, and also evaporation on the Lake's own surface as w^ell as within the region of its inflow. But his demonstration is, as Sieger emphasizes, strictly logical, in spite of the error in the premises. »Da sich keine andere Erklärung festhalten lässt, lag dem Mechaniker, dessen Geist gerade damals mit grossen Veränderungen des Meeresniveaus erfiillt war, die Annahme von Deformationen nahe; seine Beobachtungen aber schlossen es aus, sich diese, ähnlich wie er es am Meere annahm, als Hin- und Hergehen des Seespiegels zwischen entgegengesetzten Ufern aufzufassen. So bleibt nur eine Deformation zwischen Centrum und Ufern iibrig—eine wahrhaft kuhne Idee, in der Swedexborg den modernen Theorien von der 'Continental-woge' nahe kommt».

But if for this reason Swedexborg did not find the right solution of the problem, another Swede, as Sieger points out, very soon saw the con-nection between the water-level of the lakes and the quantity of rain and snow. »Birger Vassexius sammelte Daten fiber Wasserstand und Witte-rung und erkannte bald deren Zusammenhang. Zunächst in den 20:er Jahren des vorigen1 Jahrhundertes leiteten ihn theoretische Grunde —

1 This was written in 1894.auch er komite der Riicksichtsnahme auf die chemische Zusammensetzuno: nicht genug entziehen — dazu, der Verdunstung allein die entscheidende Rolle zuzuschreiben; allein fortgesetzte Beobachtung am Wenersee klärte ibn fiber das Zusammenwirkung beider Factoren auf und seine kleine Scbrift von 1758 (Swenska Mercurius, III, 406 ff.) enthält im wesentlichen dieselbe Lösung, die dem Problem heute zu teil wird. Auch zu diesem raschen Fortschritte der Erkenntnis hat Swedexborg's Vorarbeit ihren Teil beigetragen, in dem sie die Argumente und Beobachtungen sichten und ordnen half».

Swedexborg's views concerning Lake Venner are briefly reported49 in the Acta Literaria Sveciae for 1720, pp. 111—116, in connection with a number of reports concerning other Lakes, expecially Vetter. But these reports were received from the hands of others, and they refer among other things to a supposed connection between the rising and falling of adjacent lakes (Le in Dalsland, etc.). Most attention however is paid to Vetter, concerning which Daxiel Tiselius furnished information. As it is the same as that which Tiselius later on himself published in his work on Vetter1 there is no occasion for dilating upon it here.

Observations concerning the strata of mountains.

In the chapter »Observata circa strata inclinantia et de causis obli-quationis illorum» it is held7'1 2 * * * * that while some strata are horizontal others may be inclined or even have a perpendicular position, or be hent — in part convex [anticlinal], in part concave [synclinal] — or elliptical or parabolical. Even folded strata are described, although the expression is not employed. Swedenborg also seems to have noticed discordance, for he says that at Marburg and other places he has found the uppermost strata to be horizontal, while the lower ones were more or less inclined. Under the castle Biankenstein between Dillenburg and Marburg he noticed that the strata are hent four or five times up and down, and at Cassel he saw a formation hent circularly2.

1 Daniel Tiselius: Uthförlig beskrifning öfwer den stora Swea och Götha Siön Wätter. Upsala, 1723.

2 In order to ascertain which layers Swedenborg possibly had in mind by the

examples adduced from Marburg, Biankenstein and Cassel, I consulted Professor Dr.

E. Kayser of Marburg, who kindly gave me the following information. By the hori-

zontal strata, which at Marburg lie above the inclined strata, Swedenborg undoubtedly

meant the red, conglomerate-like strata of the uppermost »Zechstein» which there

cover the folded carboniferous and devonian strata of the Rhine-schists. BiankensteinBy an experiment with a mixture of clay in water, which was per-mitted to settie upon an uneven bottom in a vessel, Swedenborg came to the conclusion that the deviations of the strata from the horizontal position are related, at least to a great extent, to an uneven bottom and the settling occasioned by it. The influence of side pressure was not understood in those times.

In a subsequent chapter »De causis varietatum in stratis» the varying hardness, color, weathering, impregnation by various substances, of the strata, and their later metamorphoses, which took place after the universal flood, etc., are pointed out.73 His explanation of how this could take place by the penetration of water and other fluids through the strata, especially along the edges of the layers, is of interest and in many cases valid even today.

Not less interesting is the chapter »Observata et observanda circa strata, illorumque separationem, ordinem et diversitatem».74 Swedexborg here shows by experiment how stratification could arise by the deposition of sediment at successive times, possibly in some cases in connection with temporary drying up. He points out that the heavier (respectively larger) particles sink to the bottom first, but if a fine sediment has already been deposited and attained a certain degree of solidity, the heavier particles remain lying upon the sediment, or in other words under varying conditions the order of the various strata will vary. In this connection he gives on the one hånd an account of the strata at Helsingborg, and on the other hånd of those at Billingen. Since all the kinds of rock occur as strata, even the hårdest greystone [trap], it may be concluded that they were all originally deposited on the bottom of the sea. Metallic veins however ape exceptions to this, although some strata may also contain ores.

Interstrata also deserve to be carefully investigated, and Swedexborg gives an account of their constitution. »Nearly every change which is noticed in the strata is caused by the penetration and infiltration into the interstices of vapors, gases, water». Finally, the various objects im-bedded in the strata, such as plants, shells, other animals, etc., are also

is an old ruin of a castle built on diabase (devonian lava stream), which rests upon a middle devonian schist, the stratification of which is almost horizontal, although it exhibits a transverse lamination. Probably Swedexborg has taken this lamination to be the actual stratification. The examples from Cassel mentioned above presumably reler to the pronounced folds in the so-called »Weinberge» and their relation to the horizontal »Röth*-strata (the upper portion of the Bunter-sandstein).worthy °f a close examination, and Swedenborg refers to the various changes which they mav have nndergone.

The three chapters, of which a very short acconnt has here been given, demonstrate that Swedenborg with special exactitnde and care, and with sharp powers of observation, stndied the occurrence of the various kinds of rocks in nature, and that he collected a rich experience not only from Sweden but also from other countries. But the influence of belief in the universal flood is naturally exhibited here also.

Chemico-geological questions.

The chapter »Observata circa margam saxatilem, vulgo Margelstein dictam»77 gives an account of the characteristics of the kind of rock which the Germans called »Mergelstein»1, a limestone containing clay.

»Observata de crustis circularibus in quibusdam saxis, deque nucleis montanis».78 In a mountain in the neighborhood of the cloister Chartreux at Liége there is found a stratum of sandstone an ell thick, which is split up into parallelopipeds. When these pieces were broken up there appeared inside of them concentric rings of various colors, and this in such manner, that in cubic pieces the rings were circular, in oblong pieces elliptical, while in more irregular pieces they deviated somewhat from the circular form. (See the figures, in Plate III). The outer surface was brown, the outermost ring a lighter brown, after which followed green rings and inmostly rings of a yellow color. The inside of a piece might be hollow, either empty or filled with iron ochre, or the hollow might contain a hard kernel, etc., concerning which those interested are referred to Swedenborgs own extended account. From this it appears to be clear that an iron-holding sandstone was in question, which on weathering gave rise to the phenomenon just mentioned, although of course a fuller description of its constitution cannot be given without inspection. From the manner in which the concentric rings were arranged Swedenborg drew the conclusion that when water or some solution enters through the sides of a porous cube it will finally proceed with a circular (spherical) edge, in an oblong parallelopiped with an elliptical edge, etc. In the second Part of the »Miscellanea Observata» he returns to this in a special chapter" (Observata de influxu liquidorum ut aquae et ignis in corpora dura) and even endeavors to furnish a formula for the penetra-

1 Mergelstein, aecording to F. A. Retss (Nenes mineralogisches Wörterbuch. Hof 1798), = »verhärteter Mergel».tion of the water, which however falls ontside the province of our more particularly geological discussion.

In the chapter »Observata circa emollificationes duriorum et de origine aetitarum, belemnitarum, etc.»96 mention is also made of the sandstone at Liége referred to above, and a multitude of examples is also given of how some kinds of rock have become soft, tliat is, undergone Chemical weathering. For the special cases the original may be consulted.

From the chapter »Observatio circa stallactitas et chrystallisationes ex lapidibus oriundas, et circa similitudinem earundem cum aqua congelata»171 it is evident that Swedenborg had a thoroughly correct conception of the outer conditions necessary to the formation of stalactites. With reference to the conditions in Baumann’s cave the formation of the stalactites from the dripping water is pointed out, although naturally the chcmico-physical process could not be explained in those times. Swedenborg makes a preliminary comparison between the stalactites and the icicles which hang down from the roof of a house. He endeavors to further demonstrate that there are similarities not only between ice and stalactites or minerals of the spar-group, which break up into cubes with square sides1, but also between ice and quartz, which break up with triangulär surfaces, forming pyramids, prisms or forms with parallelogrammic sur-faces. That these have also been formed from aqueous solutions is evident from the manner in which they arise. But here there appears to be the difference that spar is derived from the water which trickles through cracks, while quartz has its origin from the very pores and hard mass of the rock.

The chapter »Observata de succo petrificante; quod non idem sit cum aqua quae stallactiten ereet»177 stands in the closest connection with the preceding. Af ter Swedenborg has given an account of the charac-teristics of the water which forms the stalactites in Baumann’s cave he points out that the bones of animals, (vertebrae, limb-bones, teeth, etc.),

x) The original here*76 reads as follows: >3. Quodque partieulae hujus secundi generis lapidis [quartz, etc.] diversum plane situm trahere videantur, scilicet talem qui pentagona, sexagona sive alias formas angulares inducat, quod videre est in chrvstalli-sationum varietate. 4. Unde distinguitur hoc secundum genus a priori in eo, quod hoc triangulariter, et in pyramidales, prismaticas et parallelogrammi formas, alterum vero cubice et in plana quadrata frangatur; et vulgo appellari solet illud Quartzium, hoc genus vero Spathum». Since in other places it is also repeated that spar splits into cubes, it seems to be evident that even then Swedenborg had noticed the cleavage forms of calcium spar.which are found in great quantities in these caves as well as in the caves at Schartzfeld, are not petrified, indeed are not even imbedded in the stalactites. There is also a kind of earth in these caves, which, although surrounded by stalactite, has not passed into stone. From this Swedenborg draws the conclusion that the water which gives rise to stalactites is not of that kind which occasions petrification, and that indeed it is known — here Carlsbad is probably referred to — that some kinds of water have the power of enerusting, but not of actually petrifying organic objects, such as branches, leaves, herbs and mosses. Swedenborg therefore supposes that petrification is caused by the same liquid which gives rise to quartz, etc., [that is, water containing silicic acid]. This is in many cases correct, but on the other hånd carbonate of lime is a no less important means of petrification, and Swedenborg himself mentions in another place90 that he at Aix-la-Chapelle saw shell-containing strata which had been converted into limestone.

The following chapter: »Observata circa origines lapidum, vulgo quarts et spathum dictorum, et rationes probabiles, quod ortum suum habuerint post tempora dilu viana»,180 also stands in close connection with the two preceding chapters. Spar and quartz are especially important kinds of stone, since they build the lodes in which veins of metal are usually found. Cracks and cavities in mountains are most often filled by them, and wdien strata in the mountains have been broken up, they cement the pieces together again, everything pointing in the direc-tion that the cavities were previously filled by some solution from which the minerals in question were crystallized. Even betwreen the surfaces of the layers we see veins of the same minerals, and in mines they fill up places which would otherwise show themselves as clefts or holes. In caves of stalactites we see the process still going on; if they were completely filled up, the stalactites, wdiich appear to be the same as spar, would form a mass resembling the lodes in mines. We also see how small cavities are filled by crystals, and since all this is proceed-ing even today, there is foundation for the belief, although it cannot be fully demonstrated, that the mineral in question was formed after the universal flood. The copper mine Kupperos in Lauterberg is given as an example where a lode resembling stalactite widens and contracts itself, the mineral vein being in the middle, as would be the case if Baumann’s cave were filled up, that is, this cave furnishes an example of an unfinished and progressing stage in the formation, while Lauterberg is in the completed stage.On the formation of mineral veins.

The remarkable chapter here referred to: »Rationes quod effluvia vel particulae minerales influant in matrices suas et illas impraegnent metallo, mediante aqua»,166 contains an especially interesting and complete presentation of Swedenborg’s views regarding the formation of mineral veins and ores, which he considers as having been caused by deposits from solutions which had penetrated into the mountain cracks. To give an account of this would itself demand a lengthy treatment, wherefore he who is interested is referred to the original. The presentation, still readable today, bears witness to Swedenborg’s thorough and comprehen-sive observations in widely separated places in Europe and must be considered as being especially excellent for the times in which it was written.

Warm springs.

This subject is treated in the chapter: »Observata cum experimentis de thermarum origine, calore et sale».85 Swedenborg first shows how water, aside from gravity, can [on account of capillarity] pass up through fine chinks (»Nullibi mélius surgere posse aquam supra horisontem sui, tanqaam sponte, quam intra strata sive lamellas exiles lapidum»). In this way the water of the springs is derived. In addition proofs are given that fire may continue or heat be preserved for centuries if the access of air be diminished. That a subterranean fire exists is certain, but it is confined to certain portions of the earth’s crust. The presence of fire is demonstrated by volcanoes, by mountains which send forth hot vapors, and hy warm springs. These are derived from the water,

which, rising in the fissures, and of course being warmed by passing the hot strata, issues at the surface of the earth as a warm spring.

In connection with this presentation an account is given of a num-ber of experiments with water from the spring at Borcet near Aix-la-Chapelle, and of the conclusions formed thence concerning the com-position of the water.

On the interiör of the earth.

In the chapter »Observata circa opinionem de igne centrali»143 Swedenborg expresses himself in opposition to the opinion then prevailing that the earth was liollow and its centre filled with fire. He thinks tliaton the contrary it is qnite solid and that the volcanoes, warm springs, etc., can be much better explained by the supposition that certain parts of the earth's crust are hot or glowing.

On miseellaneous geological observations and views.

Swedenborg mentions31 that in Billingen, near Öglunda church, there is found slate which might be used for slates, tables and the like. At one place where two powerful springs flow from two beautiful ravines there is a slate which is »hard like Swiss slate, which could be taken away in any size desired and afterwards polished for whatever use it might be needed. . . Just beside this place there is also a stream which flows from the highest peak of Billingen with great force, andp many miils are driven by it year in and year out. At this place a miil might easily be established for polishing stones by means of the water».1

In a manuscript »Om åtskillig slags Jordmohner och Gyttior» it is mentioned that in Rhyda parish in Vestrogothia there are three springs, a short distance from the rectory, one with pure water, the second with a small and the third with a great percentage of mineral water. Down below the last named is a deposit of ochre, still lower down a swamp, in which the mud (ochre) deposits itself at the bottom and becomes coal black. The thickness of the mud is 1—4 »quarters» (15—60 cm.); and it rests on fine white sand. The uppermost mud is used for dyeing black, and produces »the most beautiful black». Mention is also made of blackish fishes. These springs are also mentioned in passing in the chapter on warm springs86 on account of the peculiarity that three such different kinds of water could spring fortil from the same bed.

Another manuscript (read February o, 1720) treats of »Nya anledningar til grufwors igenfinnande eller några än oopfundna grep til at opleta grufwor och skatter, som i jorden diupt äro giömda». In the introduction a criticism on extravagance is made: »What use is there of looking for new ores in a land where so much is spent extravagantly ?»

Most of the mines have been discovered where the surface of the rock has lain bare and the ore exposed, or by accident when the ground was removed. Presumably, however, there still are great undiscovered riches in the

1 According to a kind communication from the State Geologist Dr. H. Muxthe, the hard slate referred to by Swedenborg is evidently the flinty limestone stratum in the lower part of the trinucleus schist at Offerkällan, which has been described by Muxthe. Cf. Muxthe: Beskrifning till kartbladet Sköfde, pp. 41, 42. S. G. IL, Ser. Aa, X:o 121. Stockholm 1905. See also Muxthe: De geologiska hufvuddragen af Väst-götabergen och deras omgifning. Geol. Fören. Forhandl. 27 (1905).depths of the earth, and it would be a noble art to be able to arrive at con-clusions respecting them from the outer conditions. The divining rod is notbing but a superstition. But on the contrary it is »a truth clear as daylight» that above all metals, mineral veins and other treasures there exists as it were a vapor, so that at night it shines and spreads a strong light to a great distance [!]. In mining places it is usual[?] to see fiery lights at night, which disappear when one approaches more closely; these are considered by Swedenboeg to be derived from the veins of metal, etc.1

Were our senses sufficiently acute they would indicate what exists in the depths of the earth; but this not being the case we must try other ways and note all the possible conditions which are present where ore is actually found in order to ascertain whether the conditions deviate in any way from those of the surrounding regions. For example, about 200 or 300 specimens of every kind of grass and herb should be collected in order to ascertain whether they exhibit dissimilarity above the metalliferous vein. Perhaps distinet species may even be found

there. Attention should be paid to trees, lichens, twigs, stumps, the kinds of earth, water, frost, ice, snow, insects; the relationship of various vapors should be examined, etc.

Were our senses 100,000 times finer than they are we should be able to discover by means of smell and sight how the »effiuvia» rush like streams out of the rich metalliferous veins.

This manuscript deviates much from the remaining contributions of the usually keen investigator. The circumstance that he did not print this con-tribution perhaps indicates that he himself was not satisfied, and I have therefore been doubtful whether it should even be mentioned, for we do not perform any service to a person by publishing after his death an article with which he himself was not pleased. That I nevertheless mention it depends upon this, that the series of thought itself is altogether right, although the point of departure may be defective. If, as Swedenboeg supposed, there actually were special vapors or exhalations above metalliferous veins, they would no doubt make themselves noticeable in a variety of ways, and it would then be possible to discover the metalliferous veins in the ways which are adduced by him.

1 According to a letter, dated September 21, 1906, received from the Government In-spector of Mines A. S. Backe, Bodö, Norway, since the first publication of these remarks, it seems to be a general belief not only in Cornwall, but also in other parts of Europé, that such lights are observable. To quote: »It surprised me to learn that this belief, which 1 during my stav in the mines of Cornwall as a young man in the decade of 1860 to 1870 beard expressed by old miners, has also been shared by men in the rest of Europé. My people in Cornwall were convinced that in the evenings and nights there could be seen a light above the important ores, which include Dolcoath, Cook s kitchen,

* * etc., round about Camborne. They had also sometimes observed some-

thir.g similar above other veins of metal. Even some of the master miners themselves were not free from the same belief. AV hen I spoke of the well known light observed on the one side of the Lysfjord in the district of Stavanger, which light has given the fjord ils name, the matter aroused their great attention, because they felt sure that the light came from a great supply of ore. (The phenomenon is explained by Major AVibo in Petermanns Mittheilungen)».

See also the contribution by Professor IIj. Sjögren at page 49 et seqq.Paleobotanical contributions.

As was mentioned above, Swedenborg describes a number of the fossil plants found at Liége, which lie, together with his companion, the Provincial Physician in Vestrogothia, Johan Hesselius, collected on the journey. The illustrations, which will now be examined, have been reproduced in facsimile in the accompanying Plate I. Although there are no statements concerning the scale according to which the figures are drawn, still a majority of tliem may be determined, at least as to the genus.

As long ago as 1836 Göppert1 called attention to the plant-fossils from Liége described by Swedenborg. »Auf einer Tafel Abbildungen von Abdriicken ans dem Steinkohlensandstein und Schieferthon: Fig. A, C—I, O—R Arten der Gattung Pecopteris und Neuroptteris in schwer zu bestimmenden Bruchstiicken. Fig. B scheint eine zufällige dendritenähn-liche Bildung. Fig. H. Stiick eines plattgedriickten Calamiten. Fig. L. Favularia. Fig. M. Lycopodiolithes dichotomus.1 2 Fig. N. Yielleicht ein Calamit».

Swedenborg's views concerning the fossils are found partly in the text68 and partly in the Index petrificatomm130 which accompanies the plates. If we endeavor, according to the present standpoint of science, to determine as well as is possible without access to the originals the fossils of which figures are given, the result will be about as follows.

A, C and F probably Alethopteris, while O, which is considered by Swedenborg to be of the same kind as the foregoing (»A, C, F, O, Ramusculi, ut opinor, buxi»), possibly is rather a Neuropteris.

B, »Ramusculus Tithymali Cyparrisini», cannot be determined with certainty; Professor Potonié of Berlin, with whom I have conferred in regard to the matter, suppbses that possibly an Apldebia may be in question. Goppert's

opinion, that it might be a dendrite, appears to be improbable.

E, G, K, R, »Foliola, ut puto, osmundae vel filicis», are perhaps of some Neuropteris. The little branch in the middle of K is perhaps a Lepidodendron.

D, I, P, Z, »Foliola ex ramis praedictis, ut opinor, sed majora», without doubt Alethopteris, probably A. lonchitica.

1 H. R. Göppert: Die fossilen Farnkräuter (Systema filicum fossilium). Breslau & Bonn, 1836. Nova acta etc., T. 17. Supplement, p. 18, note 1.

2 Lepidodendron dichotomum.H »est frustum quoddam a duabus partibus rotundum cum sulcis rectis, venientibus a quadam linea minori», aecording to the text, while iu the explanation of the figures there is only Lithoxylon. Probably Calamites.

L, evidently, as already Göppert held, Sigillaria from the group Favularia. The text says »Speciem praebet spicae tritici indici (mais) dicti, nisi forma esset plana», while the explanation of the figures has »exuviae, credo, piscis Schottolf vocati».

M, in the text: »an exuviae tales piscis dentur, an arboris sit foetus, dubito»; in the explanation of the figures: »exuviae piscis, Pectinis, vel Cyprini, vel Capeunae vel Pudiano dictae». It is impossible to decide with certainty from the figure whether it be a rest of a plant or not. The figure also reminds one of a Knorria form of Lepidodendron, and Professor Potonié has informed me that the wrorkingmen at the quarries always consider such specimens to be fishes.

N, in the text: »belemnitis species», in the explanation of the figures: »sive vegetabile, sive exuviae cujusdam serpentis majoris in rugas con-tracti, sive species belemnitis», appears to be an Artisia (the cast of the pit-cavity in Cordaites) and cannot in any case be a belemnite.

As may be seen, Swedexborg had a conception of the objects in question which was quite right in so far as he saw that they really were plants imbedded in the clay. That his interpretations could not at that time be right as to the details is on the other hånd evident. But still he recognized some of them as being ferns.

The circumstance that Swedexborg was the first Swede who described plant-fossils and interpreted them in a manner satisfactory for those times, led me as long as 30 years ago to name a genus of fossil plants (Sivederiborgia) after him.1 It may also be mentioned in this connection, that in the State Museum for Natural History at Stockholm, in the de-partment for fossil plants, there is a fossil tree-trunk of some size, 0.85 m. high and 0.3 m. in diameter, (Plate V., Fig. 1), which bears a printed label reading: »Petrified tree-trunk. East India. From Em. Swedexborg's collections» (»Förstenad trädstam. Ostindien. Ur Em. Swedexborgs samlingar»). There is unfortunately no further information concerning this trunk beyond what the label supplies; the trunk comes from the muse-

1 A. G. Nathorst: Bidrag till Sveriges fossila flora. Sv. Vet. Akad. Handl. Bd. 14, no. 3. Stockholm, 1876. At Belsund in Spitzbergen »Mount Swkijkxborg> (»Swe-denborgs berg») was named after him in 1898.

PI ate II.Plate III.Plate IV.Plate V.

Fiar. 1.

Petritied tree-trunk from East India, which is reported as being from the collections of Swedexborg. 1/7 of the natural size. Reproduced from a photograph of the original.

Fig. 2.

Calymniene sp. in various positions. Facsimile of Swedenborg's figure, 1717.

Fig. 3.

Atrypa reticularis. Facsi-^ »

mile of Swedexborg s figure, 1717.Plate VI.

Proterosaurus Speneri H. v. Mey. A facsimile, V3 natural size, of Swedenboiig's

plate, 1734.ura's older collections. Even with a magnifying glass it may be observed that an angiosperm is in question, but no microscopical investigation of it has thus far been carried out.1

Swedenborg, in his grcat work on Copper, etc.1 2, has furnished some illustrations of certain plant-fossils from the Kupferschiefer, but they are, as Göppert already pointed out, not original illustrations, but, together with a number of fishes likewise figured, copies of the plates in G. F. Mylii Memorabilia Saxoniae subterraneae (Leipzig 1, 1709; 2, 1718). But in Plate 84 some petrifications are delineated because of their being changed into pyrites or because surrounded by concretions of it, and in Plate 85 there is also a »Xylopyrites» or »Lithoxylon pyritosum», that is, fossil wood changed into pyrites. Tliese are presumably original illustrations.

Paleozoological contributions.

In the fifth number of Sweden's first scientific periodical, »Daedalus»,3 published by Swedenborg (Swedberg), there is delineated on the plate accompanying page 102 an enrolled Calymmene in four different positions (Plate V., Fig. 2), and besides a brachiopod (Fig. 3) which, according to Professor G. Holm, is without doubt Atrypa reticularis, one of Gothlands most common fossils. It is therefore probable that the trilobite also comes from Gothland. Differently from the rest of the figures on the plate these figures are not numbered, and the text contains no information concerning them. The figures in question are especially interesting, since they belong to the oldest illustrations of petrifications produced among us.4

As was mentioned above, Swedenborg has furnished illustrations of a number of the cretaceous fossils collected at Lousberg near Aix-la-Chapelle. These illustrations fill a complete page, and a part of a se-

1 Among the reasons for not making a microscopic examination is this, that it appears to be difficult to obtain a fragment of the best preserved parts without badlv splitting the trunk.

2 E. Swedenborg: Opera philosophica et mineralia. III. Regnum subterraneuin sive minerale. De cupro et orichalco etc. Dresdae et Lipsiae 1734.

3 Daedalus. V. For the months of January, February and March, 1717. Described by Em. Swedberg.

4 Professor L. Roberg had two years before in his treatise »De fluviatili astaco* (Upsala 1715) figured two trilobite pygidia, one of which, according to C. M iman (Studien fiber das Nordbaltische Silurgebiet. Buil. Geol. Inst. Upsala, vol. 6, 1905), belongs to Megalaspis limbata.cond (Plates II. and IV.) Only those which are found on the former page are furnished with letters, which refer to Swedexborg's explanation, partly in the text, partly in the Index petrificatorum.15°

Four years ago I sent prints of the plates to Professor E. Holzapfel of Aix-la-Chapelle, in order to ascertain whether the illustrations permitted of the determination of the fossils, and he in answering communicated that »von den abgebildeten Fossilien sind eine gute Anzahl sofort und sicher bestimmbar, andere zweifelhaft oder unbestimmbar».

The determinations carried out by Professor Holzapfel are given below with Swedexborg's own titles in parentheses.

R. Serpula tuba Goldf. (»Tubuli vel penicilli marini»).

S. Turritélla sp. (»Pectunculi cum turbine»).

T. Trigonia Vaalsiensis J. Böhm. (»Pecten gematus»).

V. ? (»Chama aspera Belion, ut credo»).

W. Turritélla sexlineata Rom. (»W, X, C Turbines longi»).

X. Turritélla sp. Unsicher bestimmbar. C?

Y. Serpula filiformis Goldf. (»Tubuli alii parvi vermiculares»).

Z. Pectuncidus Geinitzii d'Orb. Fragment. (»Species Tellinae»).

A.? (»Pecten»). B.?

D. Ostrea laciniata Nilss. (»B, D Conchae longiores, Rondels: ex materia chrystallina, cum parvis chrystallis intus»).

E. ? (»Musculus cum inclusis pectunculis et turbinite»).

F. ? (»Ghama levis»).

G. Vola quadricostata Sow. (»Pecten»).

H. Cfr. Cardium Marquarti Mull. (»H, M Pectunculi partim sabulosi, partim chrystallini»; M is not found among the figures).

I. Tapes faba Sow. sp. (»Coneha rugosa»).1

K. »Microbacia coronula Goldf.» (»Arundo fracta»).

L. Pecten virgatus Nilss.

On the second plate (IV.) there are four fossils delineated, of which but two are determinable. One of these is Ostrea Goldfussi Hzl, wliile the second contains among others what is clearly a Pecten virgatus Nilss.

Professor Holzapfel has consequently been able to identify not less than 11 species, which demonstrates that the plates must be considered as having been rather carefully executed.

It would seem that Swedexborg's observations concerning Lousberg

1 »Coneha rugosa» certainly stands at F, but since F was before used for »Chama levis», and is missing in the explanation of figures. there is probably a printer's error liere.and its petrifications have not been noticed by the German geologists; Professor Holzappel namelv writes about this in his letter of Sept. 21, 1903: »Ihre freundlichen Mitteilungen iiber Swedenborg haben mich

naturlich sehr interresiert, um so mehr als mir nichts davon bekannt war, dass Swedenborg tiber den Lousberg und seine Fossilien nberhaupt etwas geschrieben hat. Ich bezweifle auch, dass die geologische Litteratur die Swedenborg'schen Mitteilungen iiberhaupt berticksichtigt hat. Mir wenigstens ist nichts davon bekannt geworden».

But the most interesting of Swedenborg's contributions in the paleon-tological held is the illustration of a saurian skeleton furnished by him, which is given in plate 2 (not II) in his great work» De Cupro», etc. It had been found in 1733 in the Kupferschiefer at Gliicksborn, not far from Altenstein in Sachsen-Meiningen, and was preserved by" the Councillor of the Court and Mines Trier in Dresden. From Swedenborg's diary for 1733 it is seen that he visited Trier on August 30, »ubi diversi generis mineras et musculos mihi videre contigerat, praeterea etiam aliquod sceleton felis marinae cum suis articulis et pedibus in lapide scissile», etc.

There is a letter from Swedenborg to Trier324, written at Leipzig, January 5, 1734, in which Swedenborg thanks him for the beautiful drawing of »felis marina» which had been sent to him, and he furth ermore asks for permission to publish it in his work (Opera philo-sophica et mineralia) and requests more particular information concern-ing the find. In the text of this work he states (p. 168) concerning the fossil in question: »repraesentat animal quoddam marinum, amphibium, vel aliud, ex cauda augurari licet felis marinae quoddam genus fuisse». His pleasure over the beautiful specimen is evident from the following words: »est inter onmes, quas vidi lapidibus impressas formas piscium et animalium exstantissima & integerrima». A reduced facsimile of Swedenborg's plate is reproduced liere, (Plate VI.), being one third of the size of the original plate.

There has been much speculation as to what Swedenborg really meant by »felis marina», and by a literal translation it has been inter-preted to be monkey, »Meerkatze»! This may have been done because, as Mr. A.

Stroh has informed me, some copies of Swedenborg's work are accompanied by a folio page with printed directions for the binder,1

1 »Dem Buchbinder zur Nachricht hat man folgende Specification der Kuppfer und Paginarum fur dienlich erachtet.»in which »Meerkatze» is also included. But it is clear that Swederborg himself cannot be responsible for this; it is more likely that he gave tlie publisher instructions written in Latin, which were afterwards translated by him, if indeed they did not come from his pen directly. »Felis» can never have meant an ape; it is employed in the Latin language for cat, and sometimes also for mårten and pole-cat, but as employed by Swederborg it has clearly only signified some kind of animal of prev. The translation of »felis marina» by »Meerkatze» is consequently just as arbitrarv as if one were to translate it by the Swedish »liafkatt» (»sea-cat», annarichas), which in faet is a fish: neither the one nor the otlier is meant. Just as unwarranted is Th. v. Sommerirg's view, that Swederborg meant the sea-bear (Arctocephalus ursinus), since in Russia it is among other things called »Seekatze» (»sea-cat»). Swederborg had in mind nothing more or less than some kind of animal of prey (probably one living in the sea).

The specimen figured by Swederborg was however not the first one of this species which had been found, although he had no know-ledge of the preceding finds. As early as 1706 a specimen had been described by Chr. M. Sperer, a second by Lirck, in 1718, and Swederborg's was consequently the third which came to the know-ledge of the learned world. All of these specimens are mentioned in 1808 by Cuvier, who also furnishes a reduced copy of Swederborg's plate1. »La troisiéme», the text reads, »est gravée dans le Traité de Cupro, du fameux Emmaruel Swederborg, pi. 2. L'auteur la regarde comme une espéce de guenon ou de sapajou», etc., so that liere the »Meerkatze», referred to above, eontinually and without any justification still haunts the reader, in opposing which H. v. Meyer (see below) remarks, that »kein angesehener Scliriftsteller felis marina mit Meerkatze tibersetzt håbe.»

Cuvier, who also mentions Swederborg's specimen in his great work »Ossements fossiles» in exactly the same words as in the work quoted above, supposed that the fossil was a monitor, but H. v. Mever, in his work on the saurians of the Kupferschiefer,2 has demonstrated that a peculiar reptile genus Proterosaurus is in question, which is now referred

1 Cuvier: Sur les ossemens fossiles de crocodiles, et particuliérement sur ceux

des environs du Havre et de Honfleur, avec des remarques sur les squelettes des sauriens de la Thuringe. Ann. du niuséum 12 (1808), p. 79, taf. 10, lig. 2.

H. von Meyer: Zur Fauna der Vorwelt. (3). Saurier aus dem Kupferschiefer der Zecliensteinformation. Frankfurt am Main 1856. Folio.to the order Rhynchocephalia. Zittel expresses himself i o regard to these reptiles as follows:1 »Die Rhynchocephalen, von denen gegen-wärtig nur noch die einzige Gattung Splienoclon (Hatterid) in Neu-Zee-land lebt, besitzen die primitivsten Merkinale und durften den Urrepti-lien, aus welchen alle iibrigen Ordnungen hervorgegangen sind, am nächsten stehen.»

From this it is clear that the fossil in question is of great scientific interest. The species was called by v. Meyer, after the discoverer of the first specimen described: Proterosaurus Speneri. He figures the spe-cimen of Swedenborg on Plate 8 and savs that it is unusually well preserved. It is now kept in the »Naturhistorisches Hofmuseum» at Vienna.

A Retrospect.

From the account given in the preceding pages the statement made in the beginning of this Introduction is justified, namely, that Swedenborg's contributions in the field of geology are of such a sigui-ficance and sweep, that tliey alone would have been sufficient to have secured him a respected scientific name. At the early age of thirty-five — he was horn in 1688 — he had published a majority of the works of which an account has here been given, and he afterwards added to them, in the field of metallurgy, the two large volumes on Copper and Iron. In the preceding pages, if the petrifications figured in the work on Copper be excepted, no attention has

been paid to these two works, but it would be desirable that an account of them should be given by some person competent in the departments mentioned.1 2

One immediately notices in studying Swedexborg's geological writings that an investigating nature of the highest rank is in question, which on a solid foundation and witli sharp powers of observation noticed everything, even what was apparently insignificant, in order to draw con-clusions from it, and which when possible endeavored to control the

1 K. v. Zittel: Grundziige der Palaeontologie, p. 635. Munchen & Leipzig 1805.

2 It may be of interest to here quote one of A. E. Nordexskiold's statements concerning Swedexborg: »known in the history of the natural Sciences by various geological contributions excellent for his time, by a remarkable work on the atomic theory, by some investigations in crystallography, by the largest and most comprehen-sive handbook in metallurgy in its dav, etc.» (A. E. Nordexskiold: Ett blad ur de svenska naturvetenskapernas historia. Framtiden, tidskrift för fosterländsk odling utgifven af C. v. Bergex. Ny följd, första årg. 1877, p. 24).correctness of the same by experiment. The wealth of observations whicli he collected from various parts of Europe is astonishing, and he did this at a comparatively early age. Even if he did not free himself from the incorrect view that Noah's flood extended over the whole earth, he nevertheless saw that many phenomena which testified to a higher water-level in former times did not arise from the so called universal flood, and this in itself involves a step forward in the direction of a complete liberation from the dogma which had prevailed up to that time, and which had exercised so restricting an influence on the development of geology. The condition of chemistry at that time was a great disadvan-tage to him, for he could not make use of it to arrive at a final solution of various questions, even when he was on the right road. But the many-sidedness, to which his geological works bear witness, is truly remarkable; nearly all questions of great significance for the geology of that time are touched upon by him, and still these works are but the minor portion of his whole scientific activity, which in many respects w^s far ahead of the times. For he was also a mathematician, astronomer, cosmologist, physicist, mechanic, chemist, anatomist and physiolo-gist. What Anders Retzius said concerning Swedenborg's »Regnum animale», that it is a »wonder-book», in which are found »ideas belong-ing to the most recent times, a compass, induction and tendency, which can only be compared to that of Aristotle», seems after the experi-ence now attained to be capable of application to practically the whole of his scientific activity. His was a mighty spirit, of which our country has the more reason to be proud, because it was united with a personality in every respect noble and unassuming.

The works of Swedenborg which are of geological or partly geological content.

A. Meprinted in the edition of Swedenborg »Opera quaedam aut inedita aut obsoleta de rebus naturalibus*, published under the auspices of the Royal Swedish Academy of Sciences (1—5 in the first volume, G in the second).

1. Om watnens högd och förra werldens starcka ebb och flod. Bewjs utur Swergie. Stockholm 1719.1

2. Anmärckningar om musslor, sneckor etc. i kalcksten; och om skifwer. In manuscript in Codex »XL. Bibliothecae Lincopiensis».-93. Om Wennerns fallande och stigande och huru wida thet härröra kan af wattnets tillopp eller aflopp igenom strömmar. In manuscript in Codex »XL. Bibliothecae Lincopiensis».33 (2 and 3 in photolithographic facsimiles of the MSS. of Swedenborg, published by the New Church in North America and England by R. L. Tafel; see Vol. I., Emaxuelis Swe-dexborgii Miscellanea physica et mineralogica ex annis 1715 ad 1722, Stockholm, 1869).

4. Excerpta tria ex Actis Literariis Sveciae ex annis 1720—1721.41 (1. Resumé of the treatise On the Height of water, etc.; 2. Various observations on Venner and Vetter, communicated with Swedexborg's, together with a resumé of the treatise On the Falling and Rising of Lake Venner. 3. Swedexborg's letter to Jacob a Melle.

5. Miscellanea observata circa res naturales & praesertim circa mi-

neralia, ignem & montium strata. 1—3. Lipsiae 1722. Pars quarta

miscellanearum observationum circa res naturales & praecipue circa min-eralia, ferrum et stallactitas in cavernis Baumannianis etc. Navpotami

vulgo Schiffbeck bey Hamburg 1722.59-191

6. Prodromus principiorum rerum naturalium, sive novorum tenta-

minum chymiam et physicam experimentalem geometrice explicandi. Amsterdam 1721. 16:o.

B. JSFot reprinteä.

7. Opera philosophica et mineralia. II. Regnum subterraneum

sive minerale. De ferro deque modis liquationum ferri per Europam passim in usum receptis: deque conversione ferri crudi in chalybem: de vena ferri et probatione ejus: pariter de chymicis praeparatis et cum ferro et victriolis ejus factis experimentis &c. Dresdæ et Lipsiæ 1734. Folio.

8. Opera philosophica et mineralia. III. Regnum subterraneum

sive minerale. De Cupro et orichalco deque modis liquationum cupri Europam passim in usum receptis: de secretione ejus ab argento: de conversione in orichalcum: inque metalla diversi generis: de lapide cala-minari: de zinco: de vena cupri et probatione ejus: pariter de chymicis præparatis et cum cupro factis experimentis &c. &c. Cum figuris æneis. Dresdæ et Lipsiæ 1734. Folio.

C. Mann scripts. (In Codex »XL. Bibliothecae Lincopiensis»).

9. Om åtskilliga slags jordmohner och gyttior.

10. Nya anledningar til grufwors igenfinnande eller några än oop-fundna grep til at opleta grufwor och skatter, som i jorden diupt äro giömda.EMANUEL SWEDENBORG AS A COSMOLOGIST

SVANTE ARRHENIUS

WITH FOUR PLATES

a

STOCKHOLM

AFTONBLADETS TRYCKERI 1908EMANUEL SWEDENBORG AS A COSMOLOGIST1

BY SVANTE ARRHENIUS.

The present volume of Swederborg’s scientific works contains his perhaps most highly valued work »Principia rerum naturalium».1 2 In this work he attempts to give a philosophical presentation of what we might call molecular structure. Now since Swederborg considered every-thing in the world, the small as well as the great, to be constructed according to the same fundamental principles, he has also in this work presented his views concerning the structure of the solar and world systems, which views have won considerable praise for the reason that the planets are described as having gone forth from the sun by means of a kind of centrifugal expulsion, a view which subsequently became classical in the works of Buffor, Kart and especially of Laplåce. We also find in Swederborg’s Principia reflections concerning the relation of the solar system to the milky way which remind us very much of the later expressions of Wright, Kart and Lambert. In this Introduc-tion Swederborg’s cosmology and physics as set forth in the Principia

1 Translated by Alfred H. Stroh from the original Swedish and revised by the author. Now reprinted from the Introduction to Vol. II. of the edition of Swedex-borg’s scientific texts under publication by the Royal Swedish Academy of Sciences at Stockholm: Emanuel Swedenborg, Opera quaedam aut inedita aut obsoleta de rebus naturalihus, nunc edita sub auspiciis Regiae Academiae Scientiarum Suecicae, II., Cosmologica, introductionem adiunxit Svante Arrhenius, edidit Alfred H. Stroh. Holmiae, ex officina Aftonbladet, 1908. Four plates from Part III. of Swedenborg’s Principia of 1734, illustrating his theories of the development of the solar system and of the

constitution of matter, are reproduced at the close of this contribution.

2 In 1721 Swedenborg published at Amsterdam a Prodromus Principiorum rerum naturalium, reprinted in Vol. III. of this series. The Principia rerum naturalium, printed in the present volume,1-191 is in all probability the manuscript work referred to by Swedenborg in a letter dated Nov. 27, 1729, printed in Vol. I.3-1 In 1734 Swedenborg published at Dresden and Leipsic three folio volumes entitled Opera Philosophica et Mineralia, the first volume being his final Principia rerum naturalium.

A summary of the final Principia, left in manuscript by Swedenborg, is printed in the present volume,207—262 and also the entire Third Part of the Principia of 1734 2G3—338will be especially considered, but notes concerning his numerous con-tributions to pliysics, and also to chemistry, will be found in Vols. 1. and III. of this series.

As concerns the printed Principia, Swedenborg has divided it into three parts. The contents of the first and tliird parts are for the most part contained in the hitherto unprinted Principia, published below.1-191 They are mainly of a natural philosophical content, whicli is also referred to by Swedenborg in the Appendix to the printed Principia.3C0 On the other hand the second part is of physical content and Swedenborg there renders an account of a great number of experiments with the magnet. In this second part there are also found numerous references to the works of other investigators, while such references are altogether lacking in the first and third parts, whicli are clearly based exclusively upon the author's philosophical thinking. Of the first and second parts a summary by Swedenborg has been printed,207-202 corresponding for the most part to the portions italicized by Swedenborg in the printed Principia. The third part, whicli chiefly contains the presentation of Swedenborg's cosmology, has been reprinted unabridged.203-308 It is also without doubt this part of Swedenborg's scientific writings which more than any other has attracted general attention.

In order to obtain a general view of the contents of this extended work I have made a comparative investigation of the general conceptions in Swedenborg's time concerning matter and especially concerning the cosmological problems, the results of which I here reproduce.

Chemistry in those times occupied a very undeveloped standpoint. The four elements set up by Empedokles still governed the presentation of the Chemical phenomena. In physical considerations, however, the conceptions admitted in chemistry were considerably modified. Descartes, wlio without doubt exercised the greatest influence on Swedexborg's views, supposed that originally there was only one kind of material particles. By their striking each other their corners were knocked off, so that there were formed particles completely round and transparent, which were called »particles of the second kind». Out of the knocked off corners there was formed a fine dust of »particles of the first kind», which formed the fixed stars. They corresponded to the fire or light particles of those times. By their condensation there were formed opaque grosser »particles of the third kind», which occur in the sun spots; and by their further condensation were formed »particles of the fourth kind», which constitute the earth's crust.It may be seen from this that the conception of Descartes had scarcely anything in common with that which now obtains. No other experience lies at the basis of this supposition than that bodies of very differing physical properties occur. There is no further explanation of the dependence of these physical properties upon the supposed peculia-rities of the particles.

In Swedenborg's work no other change is made in these con-ditions than that the number of particles is increased and an attempt made to derive all of them from the mathematical point.

This section is not of particular interest, but of the greater interest is his treatment of the cosmological problems, which has also attracted considerable attention. We there find expressed various views which correspond more closely to our present conceptions than do those of Swedenborg's predecessors.

In the field of the natural Sciences cosmology, or the doctrine of the origin and development of the lieavenly bodies, is considered to be a part of astronomy. But on examining this chapter of astronomy it is found that most of the astronomers were not attracted by the cosmological problems, which have been worked upon for the most

part by the philosophers. Laplace, whose contribution to our cosmological conception is often brouglit forward as one of the foremost truths of science, has published it in a short note at the close of his great work Exposition du systéme du monde. On the other liand Kant has treated the same subject at great length in his Naturgeschichte und Theorie des Himmels. This peculiarity is easily explained by the faet that while ordinary astro-nomical work is rather uniform and demands an accuracy exceeding that which is found in the other exact Sciences, the cosmological presentations are usually cliaracterized by general features with rather little precision, which are derived from very different branches of science and for the working out of which fancy is used mueh more than calculation.

It is as a link in the long cliain of development of the cosmological conceptions, reaching back all the way to the oldest Greek philosophers, that Swedenborg's cosmological contributions are of considerable interest. Anaxihander (611—547 B.C.) darkly hints that an infinite number of heavenly bodies was formed out of the original chaos by some kind of a eircular motion. Empedokles (about 450 B.C.) also has a very uncertain conception that the heavenly bodies have been separated out from an originally uniform chaos. Similar views are expressed byAnaxagoras, the teaclier of Perikles. Tliese first attempts at presen-ting the evolution of the world were, however, forgotten under the in-fluence of Aristole's doctrine and the tradition of the church during the middle ages. The man who again took up the old problem was not at all an astronomer like Kopernikus or Kepler, but the philosopher Giordano Bruno. He attacked the reigning doctrine in the most violent manner and took the position that the world is infinite and tliat the fixed stars are suns, around which inhabited planets revolve. He con-sidered the planets to be floating in an infinite, transparent ocean of ether.

To this last doctrine Descartes gave a more scientific formulation. Having obser ved that all the planets are borne forward around the sun in the same direction, he concluded that this depended upon a vortex formed around the sun by the ocean of ether, which vortex when observed from the sun's north pole flows round from right to left and thus drags along with itself the planets which float in it. The planets he assumed to have entered the vortex from witliout, from cosmical space, where tliey once were suns, eacli surrounded by its own vortex. Tliese suns had however been extinguished and the vortex circling around them weakened, after which they were drawn into a neighboring mighty solar vortex. For our manner of viewing tliese things this conception that the planets are dragged along by a vortical ocean of ether seems very unjustifiable. But the conditions were alto-getlier different in the time of Descartes. He did not know about Newton's gravitation. If the planets were not dragged along but moved themselves independently, they would travel in straight patlis and soon move away from the sun. This ought indeed also to be the case with the particles of the ocean of ether. That they did not move away Descartes could explain in this way only, that they met resistance from other ether particles which were in vortices around neighboring fixed stars and so prevented the parts of the solar vortex from pene-trating into foreign regions. It was therefore very natural to assume such a vortex around the sun. Descartes assumed tliat the vortex existed perpetually.

Swedenborg, although he makes no mention of Descartes in the Principia, was without doubt most strongly influenced by the teach-ings of his great predecessor. The presentation of the system of the world as given by Descartes was presumably referred to in the lectures at Upsala as a truth generally received, whose author was not especiallypointed out since tbe views displaced by him were not thought worthy of mention. Swedenborg bas received from Descartes the doctrine of vortices of ether around the fixed stars. But in this doctrine be has made two modifications. He bas assumed that tbe vortical motion arose gradually and did not exist from the beginning. This view, also held by Kant, may be thought to have a philosophical advantage over that of Descartes, but it is opposed to tbe fundamental principles of mechanics and is therefore untenable from the standpoint of natural science, wherefore it was also abandoned by Laplace.

Tbe other modification of the views of Descartes bas won much more approval. Not witbout foundation did it seem to Swedenborg simpler to assume that tbe planets and moons of the solar system proceeded from tbe solar mass instead of having wandered in from portions of space lying outside of tbe solar system. This thought has been taken up by Buffon, Kant and Laplace and is the fundamental thought in the admired hypotliesis of

Laplace. As regards details Swe-denborg diverges essentially from his successors. Kant and Laplace assumed that the solar matter was originally spread out over a very wide space, which extended beyond the outmost planets. There, accor-ding to Kant, were formed planets by the aggregation of masses of matter; according to Laplace, by separation out of the rotating mass as the result of centrifugal force. Swedenborg on the other hånd had assumed that the solar vortex never had so great an extension. The planets had been formed by a centrifugal force depending upon a con-tinually increasing vortical motion of the solar mass, as a result of which its outmost parts were separated and cast out, having drawn themselves together into globes corresponding to the present planets and moons of the planetar}^ system. Afterwards these heavenly bodies had been gradually borne away from the sun to the positions they now occupy. There they are drawn along by the solar vortex like ships by flowing water. A similar view concerning the departure of the planets from the sun was also later expressed by Buffon, but he differs from Swedenborg in this, that Buffon assumed a concussion caused by a comet which by breaking in from outside and striking the sun gave occasion to the casting out of shattered portions of it. In recent times, however, the famous English astronomer G. H. Darwin has expressed a view concerning the removal of the planets from the sun by means of the influence of the tides. This influence acts as a brake upon the central body, by means of which the planet circling around it is lif-ted from the centre of its path. The rotation energy of the central body is thus changed into potential energy in the planet. Thus the planet's time of revolution is increased. In the same way the moon has been lifted up from its central body the earth, whose speed of rotation has thus been decreased, so that the length of a day has much increased. The tides have therefore had the double influence of lengthen-ing the day as well as the year.

These two statements are found to be already strongly advanced by Swedenborg, altliough he did not know that the influence of the tides could be adduced as a cause.

Between the times when Descartes and Swedenborg appeared upon the scene falls the period in which Newton made his remarkable disco-very of the universal gravitation (1686). This led to the admission that space is empty, since it does not offer any resistance to the movements of the planets and moons. Another consequence was this, that it is now generally supposed that bodies act upon each other at a distance by gravity. This conclusion, however, was something so antagonistic to the concep-tions of the time as inherited from the old philosophers, tbat Newton himself sharply expressed his opposition to it. This no doubt occasioned that Newton's views, notwithstanding their surpassing advantages, were for a long time unable to make themselves valid outside of England, to Voltaire being due the honor of having obtained for tliem an entrance into France and on the continent as a wdiole (1730). It is rather likely that also Swedenborg was for the above mentioned reason deterred from employing Newton's law as the basis for his cosmological reflections. This was reserved for the great scientist Buffon (the well-matched rival of Linnaeus).

Kant's attempts, however, made after those of Buffon, show far greater kinship witli Swedenborg's. Kant's attempt was finally succeeded by Laplace's celebrated nebular hypothesis, in its turn also suffering from essential defects which later times have attempted to remedy.

There is also another cosmological speculation in Swedenborg's work which is of importance. The Pythagoreans of antiquity taught that the expanse of heaven has a similar extension in all directions and conse-quently is spherical. The middle point of the sphere is occupied by the central fire, an hypothetical heavenly body, in many respects correspon-ding to the sun, which also later replaced the central fire as the middle point of the world. Notwithstanding that this view of the sun's central position was the prevailing one, and is for example accepted byKopernikus, there was not lacking even in ancient times another opinion, presumably first expressed by Demokritos, tbe greatest natural pbilosopber of antiquity, wliich opinion was this, that tbe sun is similar in rank to the stars. He also held that tbe milky way is a collection of sun-resembling stars. Neither did Giordano Bruno consider the sun to be the middle point of tbe world, but similar in rank to tbe other stars. This view was also afterwards expressed by Descartes and Swedenborg. Swedenborg added a remarkable expression concerning the system of tbe milky way, wbicb has afterwards in a somewhat changed form been taken up by a number of authors in tbe field of cosmology. He bad, like Descartes before bim, been much occupied by tbose lines around

a magnet called by us lines of force, whicli he believed depended upon emanations of magnetic matter from tbe magnet. Such conceptions are already found in Lucretius, who probablv borrowed tbem from Demokritos, as also in a highly developed form in Descartes. The lines of force lie most closely together around tbe axis of the magnet, with wbicb when most nearly adjacent they run parallel. Now Swedenborg supposed that everything in the world is constructed according to a common plan. Therefore the arrangement of the least parts of the magnetic matter should be mirrored in that system of order which ought to pre vail between the suns. Now since the suns are seen to be packed most closely along the milky way, it follows that this ought to correspond to an axis in the system of the suns. Swedenborg has not expressed himself concerning the remarkable circumstance that this axis should likely be straiglit, in which case the milky way ought to look like a semicircle in the sky. But instead this arrangement forms a closed belt around the vault of heaven. One can certainly also suppose magnetic lines of force which form a circle, as for example in a ring-shaped magnet, and we mav form a picture of the milky way in this manner, but it would be peculiar if Swedenborg had not mentioned that he had such a thought in case he really did think of this possibility. This explains why Nyrén1, who has expressed himself in regard to Sweden-borg's view of this matter, considered that it must be supposed that Swedenborg by »axis» meant something quite different from other authors, namely, »aequator». If this had been the case, .Swedenborg s opinion would have closely agreed with that which was expressed sixteen years later, and probably independentlv, by the Englishman

1 See Vierteljahrschrift der Astronomischen Gesellschaft, 1879. — The contribution of Professor Nyrén will follow in this series of papers. — Ed.66

Wright, who considered the milky way as corresponding to the ecliptic of the system of the suns. Kant was delighted with Wright's thought and took it up, without, however, according to Nyrén's opinion — Nyrén imving had access to the exceedingly rare work of Wright — having added anything essential to it.

Swedenborg also expressed the opinion that tliere are still greater systems in which the milky ways are elements, and so forth. This opinion closely agrees with a view, highly valucd by many, expressed by Lambert in his »Kosmologische Briefe», of the year 1761.

If we briefly summarize the ideas, which were first given expression to by Swedenborg, and afterwards, although usually in a much modified form — consciously or unconsciously — taken up by other authors in cosmologv, we find tliem to be the following:

The planets of our solar system originate from the solar matter — taken up by Buffon, Kant, Laplace, and others. The earth — and the other planets — have graduallv remo ved themselves from the sun and reeeived a gradually lengthened time of revolution — a view again expressed by G. H. Darwin.

The earth's time of rotation, that is to say, the day's length, has been gradually increased — a view again expressed by G. H. Darwin.

The suns are arranged around the milky way — taken up by Wright, Kant and Lambert.

There are still greater systems, in which the milky ways are arranged — taken up by Lambert.

What now is the value of the cosmological principles in general? To this question many very differing answers are given. To indicate this we may refer to the widely differing recognitions of Kant's cosmological work which have been made in various quarters. Du Bois Reymond says that »with Kant ends that series of philosopliers who were in complete possession of the scientific knowledge of their times and who participated in the work of scientists». That this view is untena-ble, is clear from H. L. Vogel's expressions: »If one now make

allowance for this fundamental error, (that Kant supposed the circling movement of the planetary system not to have existed from the begin-ning, but to have gradually developed itself), Kant's theory contains so many errors and difficulties in particular points, that it now actually is without any value». These difficulties and errors are, however, of sucha nature that they should liave been apparent even in Kants time to a man schooled in the laws of mechanics — as all the essential principles of mechanics were already known at that time.

The great Helmholtz also regards Kants cosmology as being of high value. He says of it »that it together with a series of the most happy thoughts sped far aliead of his times». It can scarcely be supposed that the acute Helmholtz made so cursory an examination of Kant's »Naturgeschichte und Theorie des Himmels» as not to liave discovered the grievous crrors in the laws of mechanics which are incident to practically every portion of this work. We must therefore suppose that Helmholtz considered Kant's cosmological speculations as having a very high value even although their execution on the mecha-nical side is untenable. This, namely, is quite supposablc, for the cosmological speculations have a philosophical side which is of at least as great signiticance as their meclianical side. So, for example, we find in the cosmological ideas of Giordano Bruno, which must indeed be described as belonging to the most remarkable in the world's history, no new meclianical considerations at all which are of any value. He has taken up the view of Aristarciios and Kopernikus that the earth moves around the sun; he furthermore expresses the grand thought that the earth is but a diminishing little particle in infinite stellar space, since innumerable stars are like our sun surrounded by circling inhabited planets — already 150 years earlier NicoLAus Cusanus had for the rest expressed the view that other heavenly bodies are inhabited — and he vehemently rose up in opposition to the prevailing astrological superstition, which lamed scientitic investigation, the view, namely, that not only the sun, but also the heavenly bodies, exercise a powerful influence upon events on the earth and especially on men. It is hardly possible to express cosmological opinions of a more deeply reaching signiticance, and still no principles of meclianical learning enter into tliem. Bruno also had to pay with his life for his daring defiance of the reigning, and as we now know, altogether false views of the time. He was in truth far aliead of his times.

To those who have valued Kant very highly belong furthermore the in-genious but in high degree eccentric German astrophysicist Zöllner, and in later times Ebert in connection with the edition of Kant's above mentioned work edited by him in Ostwald's »Klassiker». Here belong also Haeckel and C. Wolf. For the rest later scientitic investigation is rather united in depreciating the value of Kant's work, as for example During in his Kritische Geschichte der Principien der Meclianik (1873), Count L.Pfeil (1893), Eberhard (Dissertation, Munich, 1893), Gerland (1905), Holzmuller (1906) and Hoppe (1906), and it may be added H. L. Vogel in Newcomb-Engelmann's Populäre Astronomie (1905).

All of the above mentioned authors have considered Kant's work from the mechanical standpoint and have not concerned themselves with the great leading ideas in their general scope. On the other liand a philosopher König has in his work »Kant und die Naturwissenschaft» (1907) ranked himself on the other side. C. Wolf also emphasizes tlie thoughtful poesy — i. e., the philosophical depth — in Kant's expressions. Haeckel has also without doubt permitted himself to be gnided hy a philosophical (monistic) manner of treatment in his »Natiirliche Schöpf-ungsgeschichte».

It is therefore explained why the cosmological thoughts may be called grand and wonderful, as for example Kaxt's thoughts in this field, although their execution does not agree with the laws of physics. Not even the great master in the field of celestial mechanics, Laplace, has completely escaped this fate. It is now recognized by all that his so highly praised nebular theory in many points conflicts with the laws of mechanics, although it indeed in that respect is far better thau Kant's attempt. And besides it is in conflict with various astronomical and physical discoveries, among which at least one, that of the direction in which the moons of Uranus revolve, was made when he was still in his prime. There is however no one prepared to deny that this cosmological work of Laplace, although it demands working over in almost all details, nevertheless belongs to the most important scientific works which have been executed.

To take another example, one of Kants predecessors in antiquity, the famous natural philosopher Anaxagoras, taught that the original chaos had heen gradually arranged in order, so that the heavenly bodies which now exist were formed, that the sun was an enormous glowing lump of iron and that the other stars were also glowing hy their rubbing against the surrounding ether. Most thinkers are no doubt disposed lo regard his expression that the sun is made of iron as a wortliless curiosity. I however permit myself to entertain an altogether different opinion

as to this point. Spectrum analysis has taught us that iron prohahly constitutes a most essential part of the sun's matter. Observation of the constitution of metallic meteorites teaches us that iron is without comparison the most important metal in them, and from various con-siderations we view it as probable that the earth's chief mass is iron.Anaxagoras was therefore right, according to all that we know. That lie conceived the sun as consisting of iron depended without doubt upon his being led by some circumstance to the important conclusion that iron plays the chief role in inorganic nature. This was a stroke of genius and hardly an accident. In like manner would a superficially judging scientist shrug his shoulders on hearing the naive view that the stars are glowing because they rub against the ether. We know indeed that this does not at all agree with the view of our times. But I maintain nevertheless that under this formally incorrect view is hidden one of the greatest thoughts ever expressed. Scarcely one hundred years ago most astronomers, and among them the leaders, as Herschel and Laplace, had no idea that the sun required any storehouse from which it might draw the enormous quantities of heat which it pours forth, partly in the form of liglit. They did not reflect concerning this question. On the otlier hånd Kant as a philosopher did this, and also Buffon and many others before him, but among all known philosophers Anaxagoras was pro-bably the first to do so. He could not suppose that the stars ouglit not to have become extinct long ago on account of loss of heat, had not heat in some way been sustained. The mechanical part of the above mentioned conception of Anaxagoras is untenable, but the idea is nevertheless grand.

Now it is very striking that all those wlio before Laplace made con-tributions to the development of the cosmological ideas were natural pliilo-sophers, possibly with the exception of Buffon and Descartes who were also scientists of note. But it is no doubt most correct to consider their cosmological works as being for the most part natural philosophy. The same is also true of Swedenborg's work in that he labored but little in working out in phvsics his widely comprehensive and most remarkable ideas.

A question still remains to be explained, and that is to what extent Swedenborg's ideas have formed the basis of the works of his successors. That one among them who agrees most closely with Swedenborg is Kant, of wrhom it is well known that he had applied himself to Swedenborg s works. Kant himself says in 1766 that Swedenborg as if by inspiration had discovered scientific relationships which Kant had only been able to explain after mauy and lengthy investigations. It is for those who com-pare Kant's speculations concerning inhabited worlds in his above mentioned work with Swedenborg's accounts of his visions quite manifest that Kant has borrowed his ideas from Swedenborg and clothed them in more philosophical garments. It is therefore not improbable that he has alsoin other parts of the same work been under Swedenborg's immediate in-fluence and worked o ver his ideas. On the other hand it does not seem as if Wright had known Swedenborg's similar thoughts. I cannot express myself more decidedly since I have not had access to the original, but it would appear as if Nyrén considered Wright's work to be inde-pendent of Swedenborg's. As concerns Buffon, it is known that he possessed Swedenborg's Principia in 1736 and it is indeed possible that he was led to his cosmological speculations through Swedenborg's work. But Buffon's views differ in high degree from Swedenborg's, so that it would be incorrect to hold that he derived any great service from Swedenborg's opinions. There is indeed no doubt that Buffon knew the vortical theory of Descartes, which was at that time generally promul-gated in the universities, which theory Buffon's views resemble as little as they do Swedenborg's. Laplace knew Buffon's views, but hardly Kant's and still less Swedenborg's.

The cliief interest in Swedenborg's cosmological conceptions lies in this, that they form a link between the cosmological conceptions of the ancient philosophers and of Descartes on the one side and those of Kant on the other side. Similarly to the conceptions which they connect, Swedenborg's are little developed in the mechanical direction, so that the chief weight must be laid on their natural pliilosophical part.

That Swedenborg himself considered his Principia to be chiefly of pliilosophical content appears not only from the introduction »on the means which lead to true philosophy and on the truly pliilosophical man», but also especially from the Appendix,360 where it is emphasized that his system is built of the concepts »finita», »activa», and »elementaria». He says that he has not published his wTork to wdn the favor of the learned world, or a name or farne, neither wTill it concern him if no one will give recognition to his work — in this respect he

takes an entirely different position about' six years before in the hitherto unprinted Principia. A man who is striving to find the truth of philosophy does not concern himself as to such things. »Neither do I wish to ask anyone to depart from the principles of the illustrious and ingenious authors and to accept my own, wherefore I have not wished to refer to the philosophy or narae of anyone, in order not to wound anyone or to contradict another's opinion and not to appear to wish to in any wise diminish his renown». »Truth is one and speaks for itself.»

He however refers to a single philosopher, remarkably enough none more significaut than Christian Wolff, who »has contributed much tothe extension of true philosophy». To him Swedenborg expresses great thankfulness for tlie use he has had of Wolff's works in the revision of the Principia. It has however not been possible for me after comparing it with the works of Wolff referred to, to find those parts of Swedexborg's presentation in which he has permitted himself to be in-fluenced by Wolff's views, excepting in the use of certain terms.

One must admit that it is a grand thought to attempt to furnish an explanation of the world according to which a complete harmony reigns between the greatest and the least — the stellar system and the atom — or even according to Swedenborg's conception with its least part, the material point. It can also be easily understood why Swedenborg, who believed that he had happily solved this problem, felt the deepest satis-faction in a work which had occupied so large a portion of his life.TAB. III-

TAB. IV.

zj.THE SOURCES OF

SWEDENBORG'S EARLY PHILOSOPHY

OF NATURE

BY

ALFRED H. STROH

STOCKHOLM

AFTONBLADETS TRYCKERI 1911THE SOURCES OF

SWEDENBORG'S EARLY PHILOSOPHY OF NATURE

BY ALFRED H. ST RO Ii.

The Cartesian Controversy which raged at the University of Upsala from 1663 to 1689 forms the proper historical background for Sweden-borg's early investigations in the field of the natural Sciences. It will therefore be best in the present discussion of the sources of Swedenborg's early philosophy of nature, in the course of which the relation of his investigations to those of Descartes, Newton and Polhem will be con-sidered, first briefly to describe the course of the Cartesian Controversy at Upsala and its influence upon the founders of that scientific movement at the University which in 1710 was organized as the Collegium Curio-sorum and subsequently developed into the Royal Society of Sciences of Upsala.

The Cartesian Controversy at Upsala University, 1663—1689, and its influence upon the founders of the Royal Society of Sciences of Upsala, first organized in 1710.1

The inner history of Sweden after the Thirty Years' War- exhibits a series of changes affecting in a fundamental manner the politics, social

1 See an address on »The Cartesian Controversy at Upsala, 1663—1689, and its connection with Swedenborg's nebular hypothesis», in Verhandlungen des III. Internationalen Kongresses filr Philosophie, Heidelberg, 1908*, pp 248—255. The same volume also eontains, pp. 241—246, a contribntion entitled »Relics of Descartes' visit to Sweden,order and intellectual standards of the whole people. Qucen Christina, the gifted daughter of the great Gustavus Adolphus, adorned her court by inviting to it many learned and talented men from the Continent,

among them the philosopher Descartes. But for the premature death of Descartes, the Queen would have established an Academ}'' of Sciences at Stockholm, which might have ameliorated the severity of the intellectual changes whose advent during the latter half of the seventeenth century was accompanied by so much controversy and animosity at the University of Upsala. The final outcome was the establishment of philosophical freedom and of untrammeled scientific research. Strangely enough, Charles XI., whose political power was well nigh absolute, a power built upon the ruins of the authority of the nobles, exercised a determining iufluence upon the great controversy at Upsala in the direc-tion of increased freedom of discussion and liberty of teaching. The occasion of the difficulty was the entering of Cartesianism into the Fac-ulty of Medicine, but as the discussion proceeded its scope extended, involving the remaining Faculties of Philosophy, Law and Theology in a general controversy concerning the relationship of theology, philosophy and the Sciences.

It appears improbable that the short residence of Descartes at the Swedish Capital was accompanied by any events which were directly connected with the subsequent controversy at Upsala, although it is known that the learned were opposed to the foreigner Descartes, just as they were opposed to the other foreigners at the court. Queen Christina was so much affected by the philosophy and personal history of Descartes that not long af ter his death she ordered that no priest should be granted a professorship in the Faculty of Philosophy at Upsala; Descartes had recently suffered from persecutiou in Holland.

especially a newly discovered portrait by David Beck». The account of the Cartesian Controversy and its influence upon the founders of the Scientific Society at Upsala and upon Swedenborg, furnished in the present Introduction, is based in part upon the author's investigations and in part upon the admirable works of Dr. Claes Annerstedt, former librarian of Upsala University. See his »Bref af Olof Rudbeck den äldre», Upsala, 1893—1905, and »Upsala Universitets Historia», Vol. II., 1908— 1909. The valuable article of Svedelius in the periodical »Frey», 1842, as also Baili.et's »La Vie de M. Descartes», besides many other sources, have been consulted. More detailed information, with full references to the literature illustrating the Cartesian Controversy and its effect upon the intellectual atmosphere at Upsala will, it is hoped, appear in a monograph to be published at Stockholm.The University of Upsala was founded in 1477 and was naturally saturated with the tlieology and scholastic phiiosophy which then pre-vailed. Aeistotle reigned supreme in the philosophical camp except for the inroad which had been made by the anti-Aristotelian doctrine of Ramus. The Cartesian Controversy began in the Faculty of Medicine, where the first Cartesian in Sweden, Olaus Martini Stenius, had been Professor. He was the teacher and predecessor of the famous anatomist and author of »Atlantica», Olof Rudbeck. Professors Rudbeck and Hoffwenius, both of the Faculty of Medicine, had studied in Holland, where Descartes had spent twenty years of his life and acquired a great influence. In 1663, in connection with a disputation of Hoffwenius, the rumor began to be spread that Cartesianism had entered Upsala, which led to complaint on the part of the priests, in session at Stockholm. That the Cartesian movement met with opposition is also shown by some lines which a teacher in Linköping sent to Upsala by the hands of some departing students. He wrote: »Would that the atoms, pores, and efflu-via of the sun might not obtain too great a dominion in your academy, so that the young men are drawn away by the desire for novelty from the useful and ancient manner of philosophizing, so that when returning to their parents they cause more pain than honor, not knowing anything else but how to prattie about atoms, etc.» Although there was not lack-ing sympathy in the Consistory with this complaint, it was nevertheless felt that such an admonition was rather strong and that itwaspro-duced by *imbeccilitas animn, so the Rector was instructed to give the author, Andreas Ajalinus, a »scrape». The discussion concerning Cartesianism might not have become so acute during the early period of the controversy had not some of the professors been prepared to wel-come an opportunity for revenging themselves upon Olof Rudbeck, who had shown himself to be an unflinching euemy of laxity and incom-petence.

All the prominent representatives of the revolutionary Cartesianism were professors in the Faculty of Medicine, and when Professor Hoffwenius in a disputation gave evidence that Cartesianism had entered the University, the House of Priests took up the question in the Parlia-ment of 1664. The proposal that the lectors of physics in the gymna-sia should also be medical men was rejected, and for the reason that most of them were Cartesians. A

deputation of priests was sent to the Chancellor, Magnus Gabriel de la Gardie, to prevail upon him to pre-vent the youth at Upsala from promiscuously hearing »subtilities, even perhaps sucb as tliey do not understand, like the Cartesian philosopb}', whose autliors say that things of faith are probably set forth by the Holy Spirit, but not so matters in physics, chronology, etc., which are determined by the opinion of the multitude». The Chancellor was not pleased by this advice, practically a criticism of his govcrnment of the University, wliere the news of the proceedings against Cartesianism was received with much displeasure, Rtjdbeck saying that but few had read Descartes' philosophy and that none of the students understood it. But not long after one of the students, Urban Hjärne, later known as an enlightened scientist, and the chief of a Chemical institute, defended another disputation by Hoffwenius, the Cartesian tendencies of which were found to be so obnoxious to the theologians that a long discussion followed, which, however, did not lead to a decisive victory for either party. Hoffwenius refused to have his disputation altered, the theologian Stigzelius and his supporters refused to have it ventilated unless altered, and finally both parties rested on their arms, although personal friction continued. One of Rudbeck's disputations had also been found too Cartesian and the attacks against him for this and other reasons did not cease.

After a truce, extending from 1668 to 1686, during which Cartesianism made steady progress at Upsala among the teachers, the contro-versy broke out anew. The House of Priests, influenced by the Upsala theologians, approached the King, Charles XL, with a written application, the spirit of which was to prevent the study and dissemina-tion of Descartes' teachings at the University. Among the means proposed to accomplish this purpose the following sufficiently indicate what drastic steps were resolved upon. It was advised that the Theological Faculty should be placed in a position of censorship over the whole University, and not only that the Cartesian philosophy should be forbidden, but that the study of the Aristotelian philosophy should be encouraged by special support, and that no stipends should be granted except to those who accepted Aristotle's philosophy. All disputations, as well as the authors in philosophy to be lectured upon, were to be passed upon by the theologians. Finally, all disputations, and also all books from foreign countries, were to be admitted only after having been passed upon by a censor. In order to crusli Cartesianism in its former strong-hold, the Faculty of Medicine, it was proposed that the professorshipof physics, which had been placed in that department by the Constitu-tion of 1655, should be removed tberefrom, and placed in the Faculty of Philosophy, and the chair occupied by a loyal Aristotelian.

The discussion was not so much concerning the principles of Des-cartes' philosophy as concerning the limitations to be imposed upon the leaders of the dawning natural Sciences, who, basing themselves upon experiments and the principles of Descartes were demonstrating the laws of nature from its own phenomena, thus destroying the structure of Aristotelian Scholasticism not only in the held of the natural Sciences, but even in that of theology itself, thus endangering religion.

If Charles XI. thought to pour oil upon the troubled waters by sending the accusations of the priests to the accused party, the Univer-sity, the results were certainly discouraging. The Theological Faculty was opposed by all the remaining Faculties. Rudbeck's influence in the Medical Faculty was strongly in support of Cartesianism, which had also found a powerful supporter in the Faculty of Philosophy in the person of Johannes Bilberg, Professor of Mathematics. The King had sent the accusations to the University in January, 1687; all the Faculties had replied by May. The King permitted the matter to rest for two years, possibly to await the assembling of the next Diet, which met in 1689. The whole question was then placed in the hands of a committee of five statesmen, who, after hearing the evidence, recommended wliat was in form a compromise, but in actuality a rejection of the accusations against Cartesianism. On the 17th of April, 1689, the King rendered a formal decision that the doctriues of the Christian faith might not be subjected to philosophical criticism, but as for the rest philosophy should be free in practice and discussion. The coutroversy at Upsala continued for years after the decision, but the crisis had passed. Bilberg was removed from the Faculty of Philosophy, and, that peace might be restored, was appointed Professor of Theology! The appoint-ment, however, failed to restore peace. Xot only was further fault found with his philosophical position as set forth in two theological disputations, but another Cartesian, Eric

Castovius, was also subjected to severe criticism on account of a disputation, which had been passed upon by Bilberg. But the fundamental question of freedom of discussion and teaching had been answered by the King's decision hThe general results of the controversy were greater freedom of thought and a direct stimulus to unfettered philosophical and scientitic research. In 1710 the Royal Society of Sciences of Upsala was organized and counted among its members during the century such men as Swedenborg, Celsius and Linnæus. The direct influence of the Cartesian phi-losophy upon the founders of the Society will be discussed below.

In the case of Swedenborg the influence of the Cartesian Controversy soon appears upon examining his early scientific writings. He also refers favorably to Descartes in connection with some remarkable theo-ries in physiological psychology, and even in his later theological works, in a treatise »De Commercio Animae et Corporis», (1769), which reports a discussion in the spiritual world by the followers of Aristotle, Leibniz, and Descartes, the Cartesians are victorious. We must, however, here confine the discussion to the early scientific works of Swedenborg, which are chiefly of geological, physical and cosmological content.

Beginning with mathematical, physical, Chemical and mechauical researches, partly published in the »Daedalus Hyperboreus», the earliest scientific magazine of Sweden, edited by Swedenborg at Upsala, 1716 — 1617 1, the young investigator applies himself to geological questions at a time when geology as a science did not exist, and makes a number of remarkable discoveries which have been discussed in detail by A. G. Nathorst in the Introduction to Vol. I. of this series. Swedenborg was also deeply interested in astronomy, and when his early studies had been reported in a series of publications which appeared from 1716 to 1722, we find him turning his attention during the next decade to general cosmological problems. At the same time he was collecting information concerning the metals and smelting processes, in connection with his duties as au assessor in the Royal College of Mines. The results of his work were published in 1734 at Dresden and Leipsic in three folio volumes entitled »Opera Philosophica et Mineralia», printed in handsome style by the munificence of the Duke of Brunswick-Liineburg. The first volume contains the »Principia Rerum Naturalium», the second and third are works on »Iron» and »Copper» 2.

followed him to Örebro, the Cartesian psychologist Andreas Rhydeuus, eubsequently professor at the University of Lund, kept alive the flame which his teacher had so zealously guarded. Rhydeuus was the uncle and educator of Nils Retzius, the father of Anders Jaiian Retzius.

1 The D.edalus will be published in Vol. IV. of this series.

2 The three volumes of the »Opera Philosophica et Mineralia» will be included in the present series.The »Principia» has been the subject of some discussion by astronomers and cosmologists, most recently by S. Aerhenius in the Intro-duction to Vol. II. of this series. The early physieal philosophy of Swedenborg gradually developed into more and more abstract theories of the origin of matter, its composition and motions, culminating in the philosophical and metaphysical introductory chapters of the »Principia» and iu the »Prodromus de Infinito».

Among the evidences which indicate the infiuence of the Cartesian Controversy upon scientific and philosophical investigations at Upsala is the faet that most if not all of the founders of the Scientific Society, first established in 1710 as the Collegium Curiosorum, were Cartesians. We have certain knowledge that this is true of nearly all of the founders, of Lars Roberg, Pehr Elvius, Harald Wallerius, and of his son Johan Wallerius; and probably his brother Göran, as also Olof Rudbeck, Jr., should be included in the list of Cartesians. On account of the pest at Upsala in 1710, Swedenborg's brother-in-law, Eric Benzelius, Jr., invited se veral of the professors of the Faculties of Philosophy and Medicine, in which it will be remembered the principles of Descartes had found tlieir most ardent supporters, to meet at the University Library once or twice a week in order to discuss literary and scientific subjects. Benzelius, the cliief founder of the Society, was at that time the University librarian. His infiuence upon Swedenborg will be discussed below h

Some of the interesting information illustrating the early history of the Society is summarized by one of its secretaries, Erik Prosperin, the professor of astronomy at Upsala, in an »Address concerning the Royal Scientific

Society of Upsala», 2 delivered before a meeting of the Royal 1

1 In later years Benzelius became bishop of Linköping and shortly before his death Archbishop of Sweden, an office which had been filled by several members of the talented Benzelius family. A brilliant and versatile scholar, and the greatest librarian Upsala University had known since its foundation in 1477, Benzelius played a most important role in the intellectual history of Sweden during the early decades of the eighteenth century. The Diocesan Library at Linköping, greatly enriched by the activity of Benzelius, contains some twenty volumes of the family correspondence and most of Swedenborg's earliest manuscripts and letters, as wTelI as other manuscript matter illustrating the history of the Collegium Curiosorum.

»Tal, om Kongliga Vetenskaps Societeten i Upsala; hållet för Kongliga Vetenskaps Academien, vid Praesidii Nedläggande den 18 November 1789, af Lrik Prospe-Swedish Academy of Sciences at Stockholm on the occasion of his leav-ing the presidency of that body in 1789. Pbosperin says: »The pest in 1710 had driven the youth from the seat of learning at Upsala, on account of which the customary leetures for a time ceased. In order to be able, in this idleness, to forget,, at least for some moments, the la-mentable objects which met the eyes and thoughts on all sides, Dr. Erik Benzelius, Jr., who was then Librarian of Upsala Academy, persuaded some of the most famous men of the place to meet once or twice a week in the Royal Academy's library in order to discuss literary matters and to correspond with Christopher Polhem and Emanuel Swedberg, botli of whom are among the most renowned men our country has ever pro-duced. Everyone knows that the former was without a rival in his subject. The latter was in younger years one of those who worked with the greatest diligence and the best success in spreading useful Sciences. . . . The persons in Upsala who constituted this Society were espeeially the Professors Harald Wallerius, Johan Uppmarck, Pehr Elvius, Olof Rud-beck, Jr., Lars Roberg, and the brothers Johan and Göran Wallerius. They called their society Collegium Curiosorum. It is not known whether they had determined upon special activities or adopted any rules. No complete record has preserved to our time what was considered at their meetings. It is only known that the Dædalus Hyberboreus, which was published by Herr Swedberg during the years 1716, 1717, 1718, is a fruit of their labors, and should therefore be regarded as the Royal Scientific Society's lirst »Proceedings». From the subjects which are tliere found treated, and from other considerations, it may be concluded that mathematics, physics, economy, and astronomy were the main subjects of the investigations of this Society».

When the University Constitution of 1655 was adopted, the formation of »nations», or clubs of students from the various provinces of the country, was strictly forbidden, but they were nevertheless formed some

rin, Kongl. Astronom. Observator, Kongl. Vet. Societetens i Upsala Ledamot och Secreterare.» Stockholm, 1791.

Besides the abo ve the student should consult the following publications: »Kongl. Vetenskaps-Societeten i Upsala. Dess stiftelse, utbildning och verksamhet», by J. H. Schröder, Upsala, 1845; the »Essai sur la Société Royale des Sciences d'Upsal et ses rapports avec l'Université d'Upsab, by O. Glas. Upsala, 1877, and the recently issued festival publication of the Society, edited by its perpetual Secreterary Nils Dunér: »Kongliga Vetenskaps Societetens i Upsala Tvåhundraårsminne MCMX.»years later. The first inspector of the Westmanland-Dala nation was Olof Rudbeck, Sr., the professor in the Faculty of Medicine who had de-fended the revolutionary Cartesian philosophy. Since Olof Rudbeck lived until after the great fire at Upsala in 1702, and was a next-door neigh-bor of Jesper Swedberg, it is likely that Swedenborg received some impressions from this great scientist and investigator. We know that Jesper Swedberg's inclinations were not in the scientific and philosophical direction, but he himself says that he permitted his children freely to choose their own occupations. In his disputation thesis Swedenborg addresses his parent in terms of loving, filial respect, but they do not seem to have stood very near one another in the following years. Swedenborg's steps were not taken in the theological path; he himself after-wards recorded that he was kept from reading works on dogmatic theo-logy, and his work in the Faculty of Philosophy at Upsala no doubt consisted for the most part of a thorough study of the classics and of some branches of mathematics and the natural Sciences. Perhaps he also did some work in the Faculty of Medicine, for the professorship of physics, which in those days included the major part of the natural Sciences,

was in the Medical Faculty. More detailed information as to the professors, subjects, and text-books of the period 1699—1709 is fouud in the large printed folio sheets which in those days constituted the University Catalogue. It seems likely, if we may judge from certain expressions in Swedenborg's earliest letters, written soon after he left the University, that his teachers were among others the following professors in the Faculty of Philosophy: the professor of mathematics, Harald Wallerius; the professor of astronomy, Pehr Elvius; and the Schyttean professor of elocution, Johannes Upmark, afterwards enuobled with the name Rosenadler. He also praises the professor of theoretical and practical medicine, Lars Roberg. In passing it may be mentioned that there is an oil portrait of Professor Wallerius at Upsala showing him writh one arm resting upon a volume of Descartes; and that the works of that philosopher were still studied during Swedenborg's stay at the University appears from the catalogue of 1708, which records that the professor of theoretical philosophy, Magister Fabianus Toerner, under whose presidency Sivedenborg disputed the following year, lectured on Aristotle's Logic compared with Descartes'.

Swedenborg was a student at the University of Upsala from 1699 to 1709. He then spent a few months at the episcopal residence, Brunsbo,near Scara, with his father, Bishop Jesper Swedberg, before leaving Sweden in 1710 on a journey to England. After a four years' visit in England and on the Continent, Swedenborg arrived in Swedish Pome-rania in 1714 and returned to Sweden in 1715. He seeks in vain a secretaryship at Upsala1, but is introduced by Polhem to Charles XII., at Lund, and is appointed extraordinary assessor in the Royal College of Mines. Swedenborg is now fairly established; he discusses mathema-tical and scientific subjects with the King, assists Polhem in various engineering euterprises at Trollhettan and Carlskrona, and continues the scientific studies which he had begun before returning to Sweden. Be-ginning with mathematical, mechanical, and astronomical studies, he proceeded wTith physics, chemistry and geology, and then after writing and partly publishing a series of most remarkable works on those subjects, the last of which were the »Precursor of the Principles of Natural Things»,1 1721, and the »Miscellaneous Observations,» 1722, he devoted himself for twelve years to metallurgy and cosmology, publishing, in 1734, the three magnificent folios entitled »Opera Philosophica et Mineralia.» An analysis of Swedenborg's later philosophical, psj'-chological, physiological and anatomical studies, based upon a comparison of his works of the period 1734—1745, whith the earlier series of the period 1716—1734, shows most clearly that the fundamental principles of his philosophy were worked out during the earlier period. The »Principia» is justly ad-mired on account of the new cosmology it expounds, but many of the principles there laid down are found in the works published before 1722, although a close comparative study shows that great modifications were made from time to time and that some positions were gradually aban-doned as the system developed.

The Relation of Swedenborg's Philosophy of Nature to the philosophies of Deseartes, Newton and Polhem.2

It is certain that Swedenborg's interest in the natural Sciences and philosophy had been powerfully excited before he left his Alma Mater

1 Dr. Claus Annerstedt, ihe former librarian of Upsala University, bas kinclly furnisbed me with a copy of Swedenborg's application to the Rector and Consistorv, preserved among the »Acta» of the Consistory for the year 1716.

* Much of the material employed in the previous sections, and in the remainder of this Introdnction, has been submitted to the annual meetings of the Swedenborg Scientific Association of Philadelphia, U. S. A., and published in the quarterly of that body, »The New Philosophy», since 1901.iu 1709, and that it was his brother-in-law, Eric Benzelius, who advised liirn to apply himself to thos.e subjects, is proved by Swedenborg's remarks in his earliest letters to Benzelius, and in the dedication of the work »On the Infinite.» 1

We shall not, at present, concern ourselves with an analysis of Swedenborg's early treatises on a variety of mathematical and scientific subjects, written and partly published before the year 1722, but rather attempt further to deline with some precision the sources and develop-ment of his general philosophy of nature during this early period. An abundance of evidence shows that Swedenborg had great confidence in the work of Eric Benzelius

and Christopher Polhem, and that he admir-ed and studied the works of Descartes, Newton, Pufpendorf and Rudbeck. In the earliest work published by Swedenborg after leaving Up-sala, — a »Festive Applause», printed at Greifswald in 1714 in conune-moration of the return of Charles XII. from Turkey to Swedish Pome-rania, — Swedenborg begins by referring to a doctrine of the Pytha-goreans that all things develope in cycles, proceeding and then returning to the point of departure. The student of Swedenborg's works will find this doctrine developed from time to time, especially in the »Principia» and »Worship and Love of God». Again, in a sliort paper »On the Causes of Things»,""—whether it be by Swedenborg or Polhem we can-not be certain, perhaps it is the result of joint labor, the doctrines of a series of particles, differing in size and variously compounded, derived from the Infinite, and in vortices, may be traced quite clearly. These doctrines, greatty developed, reappear in the »Precursor» 1 of 1721 and

1 In his first letter to Benzelius, written at Brunsbo, July 13th, 1709, thus only a few Aveeks after having defended his thesis at Upsala, and as Ave A\ould term it today »graduated», Swedenborg mentions his plans for the journey to England, Avhich had evidently been discussed before he left Upsala. He also refers to his plans for future study, proposing to choose a certain subject AA'hich might in time be completed. He has ahvays desired to deri ve use and improvement from »the studies, which I selected with your advice and approval, my dear Brother». He sIioavs his interest in Physics and »Natural History,» Avhich in those days meant natural science and philosophy in general, and declares his intention to collect mathematical knoAvledge, also expressing his desire to have access to the mechanical inventions of Polhem, before anything mortal happen to him. All these early dreams of Swedenborg Avere after-Avards fulfllled, and in later years, after the publication of his »Opera Philosophica et Mineralia», he dedicates to his adviser Benzelius the »Prodromus de Intinito», referring gratefully to the valuable counsel of his early guide.in the »Miscellaneous Observations» of 1722, and the culmination of their development, the theory of motion becoming more and more prominent, is recorded in the Second or Lesser »Principia», 1729, and in the »Principia» of 1734.

Among the theories which Swedenborg began developing as early as during his first visit to London, is that of tinding the longitude at sea by means of lunar observations. His interest in this subject never waned, and we find him reprinting and circulating his early work on the subject even during the latter portion of his theological period, as late as 1766, when he was 78 years old. At the time when Swedenborg was first developing this theory in London he was studying the works of Newton, and discussing astronomical subjects with Halley and Flamsteed. Now if Swedenborg had accepted Newton's results, taken as a whole, he would have rejected the theory of vortices taught by Descartes, for Newton is opposed to the vortical theory and accepts a vacuum. Swedenborg, however, although he very early formulated a theory of round par-ticles which differs from that of Descartes, never gave up the theory of various kinds of particles and vortices which Descartes had introduced into modern physics and cosmology, and which was in those days re-ceived everywliere, except in England, where the philosophy of Newton won the day long before it was accepted on the Continent and in Sweden. The condition in Sweden is well illustrated by the following question in a letter, dated the 28th of July, 1711, written by the astronomer, Pehr Elvius, to his former student, Swedenborg, during his visit in England. Elvius inquires as to »what the learned mathematicians think about Newton's principles of the motions of the planets, since they appear to be pure abstraction and not physical, namely, how one planetary body can gravitate towards another, etc., which seems to be absurd». Of this question Swedenborg says in a contemporary letter to Benzelius: »P. S. Prof. Elvius asks what is the opinion of Englishmen with regard to Newton's 'Principia,' but in this matter no Englishman ought to be consulted, because he is blind about his own (quia caecutit in suis); and it would be a crime to call them into doubt».

Swedenborg not only retained Descartes' theory of vortices, but also denied Newton's corpuscular theory of light and doctrine of the vacuum. Descartes also denied a vacuum, and it is wrell known that Swedenborg formulated a wonderful undulatory theory of light, very early ranking himself on the side of those wdio hold light to be a motion, namely,Huyghens, Hooke, and others. As every student of the subject knows, the meclianical explanation of the law of gravitation presents great diffi-culties even today. I tliink it likely that Swedenborg

came to the doc-trines of the natural point and first element, set forth in his »Principia», as a result of these early studies during which he hecame thoroughly aware of the fundamental opposition between the philosophies of Descartes and Newton.

Another stream of thought into which Swedenborg was led during the first decade of his researches, that of the subdivision of matter into particles of various sizes, was derived from the theories of the ancient atomists, Democritus, Leucippus and Epicurus, and was introduced into modern chemistry and physics by Pierre Gassendi and Robert Boyle. But there are many proofs that Swedenborg also inherited much from the alchemists, and indeed chemistry was in his day far less advanced than were physics and astronomy.

Swedenborg's early standpoint witli regard to the streams of thought to which we have just referred, namely, the Cartesian theory of vortices, the Newtonian conception of gravity and the vacuum, and the subdivision of matter into particles of various sizes, all combined to determine his future physical philosophy as developed in the »Principia» from 1721 to 1734. We find him in 1719, in the little work on the »Motion and Rest of the Earth and Planets»,:$0:! projectiug a Theorin Telluris, with which he says the theories of Descartes and Newton must be compared. And still earlier, in 1718, in a letter to his brother-in-law, Eric Benzelius, Jr., Swedenborg had begun to develope his theory of round particles, sub-sequently presented in full as the »bullular hypothesis», in the »Precur-sor» and »Miscellaneous Observations,» and again with many additions and some modifications in the two »Principia» of 1729 and 1734. In the letter to Benzelius, dated January 30th, 1718, Swedenborg writes:

»Most honored and dear brother.

»I send you something new in Physics, upon the particles of air and water, proving them to be round, which may militate against the philosophy of many; but as I base my theory upon proofs and geometry, I hope that no one will be able to advance reasons for denying it. Pre-conceived ideas received from Descartes and others will probably furnish the greatest obstacles and objections. Dr. Roberg, who in everything that is minute and subtle is himself subtle, is best able to judge re-specting it: if you would therefore be kind enougli to leave this with him, I should like to hear his opinion. If Prof. Vallerius would lay aside a little his own and his dear father's Descartes, I would also like to have his opinion. This is a subject with which I might produce a large book, as is done by the learned abroad with their speculations, but as we have no appliauces liere for so large a publication I must cut my coat according to the clotli, and introduce only the most general views. The use of this seems to me to enable us more thoroughly to investigate the nature of air and water in all its parts: for if the true shape of the particles is once discovered, we obtain with it all the properties which belong to such a shape.» 1

Swedenborg here opposes the Cartesian tlieory with regard to the sliape of the particles, and incidentally indicates how faithfull}'- Harald Wallerius and his son Johan adhered to the Cartesian philosophy. But that Swedenrorg had by no means become an opponent of the »Cartesian» tlieory of vortices is evident not only from the numerous references to vortical theories with which his later »Principia» abounds, but also from his three little works on the »Earth and Planets». 2fi9-820 Swedenborg's conception of the earth's revolution around the sun in the planetary vortex is further shown by the following quotation from his letter to Eric Ben-zelius, Jr., dated November 3rd, 1719:1 2

»Most honored and dear brother.

»A few days ago I arri ved here in Stockholm, when I was at once informed by various persons that a new discovery had been made in France affecting the inhabitants of this earth, viz. that our earth had approåched about 35,000 miles nearer the suip and that tliey had written on this subject to the learned Academies. I should like very much, for better information, to obtain more particular knowledge respecting it, viz. whether observations have been made of the sun's diameter, and its visible increase, or of the parallaxes of the planets and their supposed

1 See tho original Swedish letter in Vol. I., p. 281, of this series. The version above is a revised form of the English translation in Vol. I., pp. 296—297 of the »Documents concerning Swedenborg», edited by tbe Dr. R. L.

Tafel, London, 1875—1877.

2 The original Swedish letter from which we have quoted is printed in Vol. I., p. 290, of this series. The translation below is revised from Dr. R. L. Tafel's »Documents», Vol. I., pp. 307—309.displacement, which would be noticed, in case we approached nearer to our centre; for this could only show itself within our solar vortex, outside of which there is no possibility of any indications nor of any parallax with the sun showing itself, unless one should appear which could not be distinguished before. The greatest matter of surprise is, that such a leap should have been made within one or two years, when yet no comet has hurled itself into our larger vortex,' nor has any other planet, so far as I know, approached so near to our terrestrial vortex, that it could have forced us inwards. In case there have been some such violent cause, we may presume that our planet will again recede to its proper distance, inasmuch as this always adapts itself to the speed and to the right track. It does not seem reasonable that this should have taken place in a natural manner in so short a time, unless it is deduced from observations made for some 100 years. I am glad, how-ever, that I treated publicly a similar subject about a year ago in my treatise »On the Earth's Motion and Rest», in which I maintain that the earth moves more and more slowly both iu its anuual and diurnal revolution, from which it must necessarily follow, that it approaches nearer and nearer to our sun; for the more rapid the motion and revolution of the planets within the solar vortex, the greater is the distance to which they are carried from the centre; but the slower the motion, the more tliey are drawn inwards; moreover, it is known in what proportion the centrifugal force increases according to the velocity with which a body either tends outwards or inwards. Isaac Newton's »Principia» treats of this subject. The case with the planets is, also, as if a long arm were made, with a ball upon it, which was free, and could slide either forward or backward on the arm, and thus could move either out or in by the least force; if, now, this ball should be spun round very rapidly — especially under water — then the centrifugal force would be increased to such a degree, that the ball would run far out on the arm, away from its centre; but if the motion (primum mobile) should decrease, the ball would be drawn inward. Exactly so it is with the planets; if the first moving cause (primum mobile) decreases, the planet approaches nearer to its centre; but if the motion is increased, the plan* et is thrown far out; or what is the same thing, the slower the revolution the nearer its approach to the sun, which is the theory I discuss in the above-named treatise, which I shall show you when there is a good opportunitv. That this, however, should take place within two orthree years, I cannot yet get into my head; althougli even our atmos-phere itself seems to indicate a change in the temperature in respect to summer and winter, and also in respect to the unusual nortli winds we now have. With regard to the nature of motions, if an examination is made of the degree in which they eitlier increase or decrease, tliey are no doubt in duplicate ratio, and it appears that toward the end motion de-creases more in one moment than before in 20; for instance, if anything be whirled around, the revolution towards the end diminishes more in one moment, than it did before in 20; yet this cannot, it would seem, be applied to our planet. I should therefore like very much to obtain more exact knowledge about this matter.»

We see from the above, and from many other places in Sweden-borg's early works and letters, that although a student of Newtons »Principia», and a great admirer of his discoveries, Swedenborg did not go further and also accept Newton's doctrine of the vacuum. In agreement with the older Cartesian pliilosophy, Swedenborg found vortices of atmospheric particles necessary, and all his later explanations of the planetary and lunar motions involve the vortical theory.

In still another direction Swedenborg is in agreement with Descartes rather than with Newton. We refer to the general conceptions of the origin, composition and interrelations of substantial and material particles. While Descartes derives his series of particles from the Infinite, and Newton also holds that God in the beginning created small, impenetrable particles, by whose composition everything was formed, they differ in that Descartes accepts no creation of particles in a vacuum, while for Newton the vacuum is a postulate, even if he later on began to specu-late as to the necessity of a communicating ether. In his Principia Philosophiae Descartes expressly opposes the idea of a vacuum, but Newton was possibly led to construct his impossible corpuscular theory of light and colors just because he did accept a vacuum in his earlier work the Principia, 1686, the Opticks

not appearing until many years later, in 1704.

Since the fundamental differences between those philosophies which accept the principle of discrete spatial substances without postulating a vacuum, and those which suppose that atoms occupying space are con-tained and move in an infinite vacuum of which space is also predicated, are very well illustrated by the various theories of light and color, it will throw further light on Swedenborg's relation tb Descartes and New-ton briefly to recount the history of investigations concerning light and color up to Swedenborg's times.

Goethe has well said:1 »From time immemorial it has been danger-ous to treat of color, so much so, that one of our predecessors ventured on a certain oecasion to say, 'The ox becomes furious if a red cloth is shown to him; but the philosopher, who speaks of color only in a general way, begins to rave.'». Since ancient times the phenomena of light and colors have received the attention of philosophers, and many are the theories of their causes which have been presented. Pythagobas taught that vision was caused by particles continually projected from the surfaces of objects into the eye, while Empedocles and Plato ascribed the excitation of the sense of sight both to emanations proceeding from the objects seen and also from the eye itself. Aristotle opposed the doctrine of visual rays and emission theories in general, maintaining that light is not a material emission in any sense, but an action of a pellucid medium, thus anticipating in a general way some of the best results of modern times. Epicurus, Lucretius, and others had a con-fused notion that the eve sees bodies at a distance in a similar wav that we feel them by meaus of a rod, aud this strange idea was accep-ted for many centuries until the Arabian astronomer Alhazen showed in the eleventh century A. D. that the cause of vision proceeds from the objects and not from the eye.

The ancients were acquainted with some of the fundamental laws of optics, among which may be mentioned these: that light travels in straight lines, that the angle of incidence is equal to the angle of reflec-tion, that water aud air refract light, and that transparent balis of glass or crystal, or glass globes filled with water, may be used as burn-ing glasses.

Alhazen made great progress in the explanation of reflection and refraction, and also entered into anatomical examination of the eye. Vitellio, a native of Poland, still further extended the knowledge of refraction and reflection, drawing up some improved tables concerning them. That universal genius, Roger Bacon, if we are to accept certain statements in his works as authentic, appears to have discovered the under-lying principles of both the telescope and microscope, and to him also has been

1 *Zur Farbenlehre*, 2 vols., Tiibingen, 1810. There is a later edition and a translation of the first volume by Chari.es Lock Easteake R. A., t. R. S., London, 1840, entitled »Goethe's Theory of Colors.»100

attributed the invention of the magic lantern. The first telescope, how-ever, was, according to one version of the story, constructed by a Dutcli-man naraed Jansen, whose children while playing in their father's Morkshop accidentally placed a convex and concave spectacle glass at a short distance from each other and noticed the apparent increase in magnitude of what they saw through the glasses. They drew their father's attention to the phenomenon, and he fixed sucli glasses in a tube and sold the instrument. It is certain that the principle of the telescope was discovered in Holland, although it is not quite clear who the discoverer was. But whoever he was, Galileo, having heard of the instrument, made one himself, and with it discovered a satellite of Jupiter. Great progress was now made in the study of light and colors. Kepler, Porta, de Dominis, Snellius, Descartes, and Grihaldi both en-larged the field of discovery and corrected previous results, preparing the way for Newton, who in 1704 published his »Opticks», containing experiments of the utmost importance and presenting his theory of light and colors, which, although rejected as to its corpuscular philosophy, is still accepted by the scientific world in many other respects.1

Newton's theory briefly stated is as follows: Lights consists of material particles or luminous corpuscles sent forth from a luminous body in straight lines which by their mechanical action on the retina produce sight. He says:2

»Are not the Rays of Light very Small Bodies emitted from Shining Substances? For such Bodies will pass through uniform Mediums in right Lines without bending into the Shadow, which is the nature of the Rays of Light. They will also be capable of Several Properties and be able to conserve their Properties in passing through several Mediums, which is another Condition of the Rays of Light.»

Newton also attributes the heat of substances to the agitation of their parts caused by the action of the rays.

Newton's theory of light, according to the above quotation, is there-fore an »emission» or »corpuscular» theory, its fundamental features being similar to those combated ages before by Aristotle. Newton was well aware of the »undulatory» theory, which considers light to be due

1 For a condensed history of theory and experiment on light and color see Preston's »Theory of Light,» Macmillan & Co., 1890, of which the present account is for the most part an abridgement. For original documents see Goethe, Op. Cit., Vol. II.

* »Opticks», Bk. III., Qu. 29.to the periodic motion of a medium between the luminous source and the retina, but he thought that a ray of liglit could travel only longi-tudinally in a manner analogous to sound vibrations, and therefore, as Preston says, he »feli back upon the emission theory, and developed it with a genius more tlian mortal.»1

Newton's theory of color may be stated as follows: Every color is simply a kind of liglit. Thus when a ray of white light from the sun is passed through a prism, the various kinds of light composing the ray are separated from each other, and when one of these kinds of light is again passed through a prism it remains unaltered as to color. He thus taught that there were seven fundamental lights: violet, indigo, blue, green, yellow, orange, red, the combination of which produced white light, and he considered this proved by collecting all the refractions of his Spectrum by means of a lens and again producing white light. Newton not only thought that sunlight was composed of several different kinds of light, but in the first sentence of his »Opticks» emphasizes his opposition to all sucli conceptions as those held by Swedenborg and other receivers of vibratory and undulatory theories in the following language:

»The Phenomena of Colours in refracted or reflected Light are not caused by new Modifications of the Light variously impressed, according to the various Termiuations of the Light and Shadow.»2

Newton's corpuscular theory of light was opposed by Robert Hooke, and even long before, Descartes, Lionardo da Vinci, Galileo and Grim-aldi had written in favor of the idea that light is an instantaneous pressure of an elastic medium or a vibratile movement there of. Butthe undulatory theory was first definitely stated by Huyghens in 1678, and after remaining lifeless for almost a century, was revived by Young, the discoverer of the principle of interference. It was still further strengthened by Fresnel, who introduced the idea of trans verse vibrations guessed at by Hooke in 1672. The undulatory theory teaches that the propagation of light is due to the periodic wave motion of a postulated medium called the ether, that there are millions of kinds of waves differing in length, that only a short range of these may be perceived in the Spectrum from violet to red, and that above the violet are many waves decreasing in length and noticeable in fluorescence and Chemical

1 Op. Cit., p. 21.

2 Book I, Prop. I, Tbeor. I.action, while below the red are many waves increasing in length and noticeable in thermal action or calorescence.

It should be noted that Newton also postulated an ether in which his luminous corpuscles travelled, and in which they were capable of exciting undulations.

»He also attempted to account for gravitation in an ether, but he published little of this theory, because he was not able from experiment and observation to give a satisfactory account of the medium and the manner of its operation in producing the chief phenomena of nature.»1

Swedenborg's theories of light and colors are radically different from those of Newton. The whole scheme of his

bullular hypothesis would at once prevent the formation of any theory involving the shooting of corpuscles from the sun to the earth and thus impinging on the retina, for he considers all space to the filled with degrees of matter and natural substances, differing in degree of density of composition and inertia. From the very beginning he taught that light is produced by the undu-latory motion of an elastic ether, and that colors are produced by the modification of this motion in the material objects receiving it. He developed and modified the theory from time to time, but that it was originally derived from the older workers, from Descartes, Huyghens or Hooke, is clear from Swedenborg's earliest works.

Up to the present point we have seen that Swedenborg retained the Cartesian theory of vortices and without accepting the Newtonian vacuum nevertheless employed Newton's disco very of the matliematical relation of masses in space which is commonly called the law of gravitation. With regard to the question of the constitution of matter, Gassendi and Boyle had introduced the atomic theory of Democritus, who also postulates a vacuum, into modern chemistry and physics, but Swedenborg, who studied Boyle's wrorks, and was in general much influenced by the English experimental school of thought, nevertheless differs with all those advocates of the subdivisibility of matter wliose reasoning ends

1 Preston, Op. Git., p. 26: — The student of Swkdbnborg's cosmology may be interested in the following note, quoted from the same work, pp. 25—26: »To Descartes the bare existence of bodies apparently at a distance was proof of the existence of a continuous medium between them, for he regarded extension as the sole essen-tial property of matter, and matter a necessary condition of extension. 'Ethers were invented for the planets to swim in, to constitute the electric atmospheres and magnetic effluvia, to convey sensations from one part of our body to another, till all space was filled several times over with ethers' (J. C. Maxwell).»in ultimate atoms which, while occupying space, cannot be further divided, but move in a vacuum. Swedenborg, while differing from Descartes as to the shapes and properties of his particles, still agrees with that philosopher in accepting a series of discrete substantial forms whose origin is the Infinite, and which move, not in a vacuum, that is, a great empty space, but whose relationship to one another first pro-duces space. He would therefore maintain that space is not a vacuum in which the particles move, but that it is a relationship of the extended particles. Every student of the history of philosophy and the Sciences is aware of what confusion and obscurity have prevailed concerning these prime questions, and that even today both physicists and metaphysicians accept theories which are in utter disagreement with each other. We cannot, however, here enter upon a detailed discussion of these profound questions, but must content ourselves with having defined Swedenborg's position and its relation to Descartes and Newton.

If, now, we enquire as to how Swedenborg placed himself with regard to the problems of the divisibility of matter and its properties, and endeavor to see his exact position in history, we find that his earliest statements date from a period when he was intimately associated with the Swedish Archimedes, Christopher Polhem, and that whether Polhem was or was not the author of the Chemical and physical theories which will now be referred to, Swedenborg in any case developed his own theories upon a basis which was supplied by Polhem. The evidence for this is the following.

Polhem, whose mechanical genius and numerous inventions won the admiration of his age, has left behind him masses of unpublished matter, preserved in the Royal Library at Stockholm, among which there are many dialogues and discussions which set forth his concep-tions of mechanics, physics, chemistry and dietetics. Among these manuscripts is a »Dialogue between Mechanica and Chymia on the Con-stitution of Nature», 243 which is in the handwriting of Swedenborg, but in the same package the latter portion of the »Dialogue» exists as a first draft in the handwriting of Polhem. We know that Swedenborg for a time acted as Polhem's amanuensis, and he appears to have done so in the present instance. The remarkable thing is that several of the positions of the »Dialogue» which have by students of Swedenborg been considered to be original with him in his »Precursor» and »Miscellaneous Observations», are clearly stated in the little work we are discussing.243 Thus we observe that the »Dialogue» men tions the salt particles smallerthan the water particles, which salt particles are formed at the bottom of the sea by pressure. There is also a remarkable similarity between the

positions of this work with regard to the flood, the origin of the mountains, strata, sand and clay, and the statements of Swedenborg on the same subjects. We observe further that Boyle and the Swedish chemist Hjärne are mentioned. Swedenborg was personally acquainted with Hjärne and probably derived several ideas from him. As for the authorship of the »Dialogue», there can be no doubt that Polhem draft-ed the work, but it may be that Swedenborg collaborated.

Still another question of a similar kind arises when we notice the resemblance of many expressions in the »Dialogue» to those in the little paper in Swedenborg's handwriting »On the Causes of Things».229 Both of these papers refer to the floating of a hollow bullet on w^ater and to the part which flowing glass played in the original development of the earth, an idea probably derived from the presence of quartz and other glassy looking minerals occuring in the crust of the earth. The paper »On the Causes of Things» has always been ascribed to Swedenborg, and various students have with the learned editor of the »Documents concerning Swedenborg» seen how in this early manucript »are contained the germs of some theories which Swedenborg subsequently treated more fully and established at greater length».1 If, however, we examine the manuscripts of Polhem we find a little work »De Causis Rerum», which has contents similar to those contained in the paper written by Swedenborg's hand. Polhem's paper is much longer than Swedenborg's, but contains the same headings and treats of the same subjects. The discovery of this evidence shows that if we are ever to obtain clear and satisfactory ideas concerning the sources and development of Swedenborg's philosophy of nature, and we may add of the Swedish natural science and philosophy of the eighteenth century, a much deeper investigation and historical analysis than has been attempted in the past must be undertaken. The litera-ture is very meagre, and students must therefore, in discussing the development of Swedenborg's early philosophy of nature and »Principia», rely very largely upon the internal evidence of his own works and letters, although fully admitting the probability that the publication of the extensive material left behind by the Swedish scientists of the seventeenth and eighteenth centuries which still lies buried in the public and private archives of Sweden would throw a powerful light upon the subject.

1 Dr. R. L. Tafel's »Documents», Vol. II., p. 890.NOTES

ON THE

DEVELOPMENT AND TEXTS OF SWEDENBORG'S EARLY PHILOSOPHY OF NATURE AND »PRINCIPIA».

Since the publication of Vols. T. and II. of Swedenborg's scientific texts the literature has been greatly enriched by a number of festival publications issued at Stockholm and Upsala during the past year, and also by the contributions pnblished in the Transactions of the International Swedenborg Congress held in London, July, 1910. The festival publications which bear upon Swedenborg's scientific works will be referred to in the Notes below, in which the reader will find a résumé of the latest results obtained in Sweden on the development and texts of Swedenborg's early philosophy of nature and »Principia».

Stockholm, March, 1911.

Editor.

An interval of three years has elapsed since the publication of Vol. II., and as considerable progress has since been made in the interpretation of Swedenborg's pbysical philosophy it seems advisable that the »Notes on the history and texts of Swedenborg's contributions to cosmology», published in 1908 (Vol. II., pp. 369—373), should here be revised and amplified.

In our former Notes the Cartesian Controversy, which played so im-portant a role at Upsala University during the latter half of the seven-teenth century, was referred to only in passing, but in the Introduction tothe present volume the reader will find some account of that important revolution in the intellectual life of Sweden. Viewed in connection with the historical background furnished by the Cartesian Controversy and its influence upon Swedenborg's teachers and early associates, his earliest scien-tific and philosophical contributions fall into

relationships which permit our obtaining that perspective which is so necessary for a just view of their significance. The streams of doctrine and speculation arising from the works of Aristotle, Descartes and Newton, to mention only the main sources, were all active at Upsala just before and after Swedenborg's residence at the University (1699—1709), and could not fail to influence the course of a young investigator's thoughts. In the Introduction we have attempted, even at this early stage of these historical researches, briefly to define the conditions by which Swedenborg was surrounded, when in early manhood he decided to devote himself to the study of nature.

After preliminary theological, classical, and scientific studies at Upsala Universit}7, Swedenborg defended a classical disputation in 1709. About a year later he departed for London, and, according to his earliest letters, the journey had been determined upon before his leaving the University. Bishop Jesper Swedberg, Swedenborg's father, and Eric Benzelius, Jr., his brother-in-law, had visited England and been greatly influenced by Eng-lish learning. Before leaving the paternal roof in 1710, Swedenborg sent to Upsala from Skara the skeleton of what he at the time referred to as a »giant». Subsequently the bones were found by Professor Lars Roberg to be those of an extinct species of whale. Although surrounded by the rich geological treasures of Vestrogothia, Swedenborg does not appear at this early stage of his work to have perceived the significance of the stories buried in the rocks. Probably he was so confined to the neighborhood of the episcopal residence, Brunsbo, that the wonders of Kinnekulle, about which he published an important work ten years later, were beyond his reacb, although but a few miles distant. That he chafed in his confine-raent at Brunsbo and longed to set forth upon his journey to England appears from his first letters to Benzelius. (Vol. L, p. 201 et seqq.)

Arrived in England, Swedenborg devoted his attention chiefly to astro-nomical subjects, studied Newton, and laid the foundations for his future many-sided activities in the field of the natural Sciences, as may be seen from his letters to Benzelius. On the way back to Sweden, during a stay at Greifswald in Swedish Pomerania, Swedenborg began to arrange his results into order and published a number of poems and fables, as alsoa »Festive Applause» on the return of Charles XII. from Turkey. In the opening words of the »Applause» he refers to a doctrine of the Pythagoreans that all things proceed and return in cycles, making it a leading idea in the little work, a harbinger of doctrines which were in later works again and again elaborated by Swedenborg, forming as important a com-ponent of his later philosophy as the doctrine of perpetual flux in Heracli-tus. Just before returning to his native country Swedenborg sent to Ben-zelius a letter (Vol. I., p. 225) in which he furnishes a list of the inventions then in hånd. From the letter referred to it may be seen how his mind at that time teemed with ideas which were in part elaborated and printed in the Daedalus Hyperboreus1 and which in several respects fore-shadowed the subsequent course of discovery.

Without attempting to analyze Swedenborg's numerous papers of this period, dealing with very diverse mechanical, physical, Chemical, mathe-matical, geological and metallurgical questions, let us turn our attention to his earliest contributione to a philosophy of nature, subsequently developed in his »Principia». In our former Notes special emphasis wTas laid upon the faet that Swedenborg in reality wrote three »Principia», and that the second work was evidently not from the period prior to the Prodromus Principiorum Rerum Naturalium, but of mueh later date. The second »Principia» probably dates from about 1729, thus only five years before the publication (in 1734) of the third »Principia». We shall return to this question below, and merely refer to it here in order to again draw

1 The Daedalus Hyperboreus has been reproduced in a photolithographic faesimile which will be ineluded in Vol. IV. of the present series, and a separate edition of the reproduction bas already appeared in i>Kungliga Vetenskaps Societetens i Upsala Tva-hundraårsniinne, Upsala, 1910, edited by the Society's perpetual secretary, Professor Dr. Nils Dunér, and containing ruuch historical information of interest to students of Swedenborg's earliest scientific works. This »Tvåhundraårsminne», published on November 19th, 1910, in celebration of the bieentenary of the Royal Society of Sciences of Upsala, forms one of the twelve festival publications which appeared at Stockholm and Upsala in July and November, 1910. Without here referring to the whole series of festival publications, several of which are editions of Swedenborg s early works, and all of which will be noted

in the »Chronological List» to be included in the Appendix to Vol. I. of this series, we desire to call the special attention of the student of Swedenborg's scientific works to the festival publication dedicated by the University of Upsala Till Kungl. Vetenskapssocieteten i Upsala 1910, in which is con-tained a remarkably thorough discussion of »Emanuel Swedenborg s investigations in natural science and the basis for his statements concerning the funetions of the brain,» by Martin Ramström, M. D., Professor of Anatomv at the University of 1 psala.attention to the very gradual development of Swedenborg's principles of nature from 1721 to 1734, a longer period by two years than that in which he produced (from 1734 to 1745) his great works on the human bod}'' and mind, in the analysis of which the principles previously developed were constantly applied. Now, an interesting result of recent investigations in Sweden is that even be fore 1721 the »Principia» were expressed in some of their most striking aspects in a number of short Swedish ivorks dating from about the year 7? jfS.269~320 In these Swedish works, several of which are printed in the present volume, we therefore find the original conceptions which were later expanded in the three Latin »Principia».

In the Introduction we have discus3ed the relation of Swedenborg's philosophy of nature to the philosophies of Descartes, Newton, and Polhem, and pointed out that the manuscripts »De Causis Rerum»229 and »Disc ours emellan Mechaniquen och Chymien om naturens wäsende» ,243 although in Swedenborg's handwriting, were probably more the result of Polhem's author-ship than Swedenborg's. The relationship of these texts, now first published, is, however, confined for the most part to Swedenborg's Chemical, geological and physical theories as recorded in the treatise Om Watvens Högd and in the Prodromus and Miscellanea observata. When we come to the cosmological theories of Swedenborg, the historical lines lead us partly to the ancient classical writers of Greece and Rome, partly to Descartes and Newton, as pointed out in the Introduction. Whether Swedenborg received the first hints of his »nebular hypothesis» from Ovids Metamorphoses, or from some other source than his own original speculations, has not yet been made clear. Certain it is that he did not express the theory in the fragment En vy theorie om jordens af'st ann ande,269 although it may have been in his mind then, for in discussing the decreasing motion of the earth and planets (a theory developed in our times by G. H. Darwin), the question of the original planetary and solar chaos of course lay near at hand. Be that as it may, in a work of considerably later date, to judge from the pronounced difference in the handwriting, the theory of the origin of the earth and planets from their »first lump» is clearly expressed in the opening words of the preface.28'

In the printed work,299 which, after some revision and expansion, was published at Skara in 1718, the »lump» has become a »Chaos», reminding us of the chapter in the Principia of 1734 De Chao universali solis et planet-arum. In this theory Swedenborg separates himself from the cosmological thpories existing before his time and establishes the »nebular hypothesis»,thereby anticipating Buffon, Kant, Wright, Laplace and other writers. In so far as the doctrine of vortices is concerned, Swedenborg probably derived it from Descartes, but he differs with Descartes as to the origin of the planets, for whereas Descartes derives them from outer space, Swedenborg derives them from the original chaos of the sun and planets. So far as Buffon is concerned, he had Swedenborg's work in his library two years after it was published, and did not publish his own theory of the origin of the planets by the crashing of an enormous meteor into the sun, the matter of the planets being thus splashed out into space, until many years later. Of this theory it must be admitted that it crudely re-sembles Swedenborg's in so far as the solar origin of the planets is concerned, and it also reminds us of the theories of certain modern writers who hold that masses in space may crash into one another and produce nebulae. As for the theories of Kant and Laplace, and their relation to Swedenborg's »Principia» theory, we may here quote the remarks of Nyren, who wrote on the question many years ago.1

»It cannot be denied that the essential part of the nebular hypothesis, namely, that the whole solar system has been formed out of a single chaotic mass, which first rolled itself together into a colossal ball and subse-quently by rotation separated a ring from itself, which then during the con-tinued rotation broke up into several parts, and finally contracted into the planetary masses, was first expressed by Swedenborg. The work of Kant here in question, Allgemeine Naturgeschichte und Theorie des Himmels, was published in 1755, that is 21 years later; Laplace did not publish his hypothesis until 62 years later. It should further be observed that Swedenborg has in

all probability given his hypothesis the more correct form, that, namely, as Laplace also later on supposed, the planets were formed out of broken up rings, (on the basis of the vortical theory Swedenborg found but one ring necessary) not, as Kant supposed, immediately out of conglomerations formed from the original mass of vapor.»

If we examine Swedenborg's earliest works in their chronological order we find that the three component parts of his early philosophy of nature, namely, 1) the theory of vortices, 2) the origin of the earth and planets, and 3) the constitution of matter out of grades of particles, — that these

1 Vierteljahrschrift der Astronomischen Gesellschaft, Vol. 14, 1879. See recent discnssions in the Introduction to Vol. II. of the present series, Stockholm, 1908, by Professor Dr. S. Arrhenips, and in the Transactions of the International Swedenborg Congress, London, 1910, by Professor I. Tansley.three streams ot thought, which we have briefly discussed in the Introduc-tion, follow one another during the second decade of the seventeenth century. It will be observed that their order indicates how Swedenborg passed from more general to more specific questions, from the universe to the particles of which it is composed, and, probably under the guidance of that ancient doctrine that in the microcosm we see the macrocosm, and vice versa, he was led to formulate his early philosophy in such a way as to accept the same laws as governing the least parts of nature which are operative in the grand universe. Swedenborg, so far as his works record, accepted the theory of vortices without question, but applied it successively in two new ways, 1) to the origin and motions of the planets, and 2) to the

origin and motions of the grades of »particles» in nature. The first appli-

cation is recorded in the three little Swedish works on the earth and planets published in this volume, and in the three Latin »Principia». The

second application is first found in the »bullular hypothesis» of the Prodromus and Miscellanea observata, and later, in greatly extended form, in the second and third Principia and in other works written after 1730. Prior to 1721 we find very little concerning »particles», but something of the future »bullular hypothesis» may be discerned in the De Causis Rerum,229 in Om eldens och fergornas natur,285 in the Discours,243 and in Swedenborg’s early letters, while in the Philosophia cor-puscularis in compendio,205 dating from a period long after the Principia, the cor-puscular philosophy is once more briefly summarized. As for the doctrine of the mathematical or natural points, which plays so prominent a role in the second and third »Principia», it is barely referred to in the earlier works, although it is defended and its future treatment promised in the Miscellanea observata.

A feature of Swedenborg’s early works on the »Earth and Planets» which will no doubt impress itself upon the reader’s mind, is the constant reference to the biblical statements concerning creation. That Swedenborg at that time, 1717 —1718, followed the literal account in Genesis is indis-putable, and he attempts all kinds of explanations and reconciliations of the account of creation in Genesis and of the ages of the patriarchs, etc., with the natural science of his time. This he also continued to do in the two editions of »Om watnens högd», published in 1719, in which he still accepts Noah’s flood literally. But if we compare the works of this period with one another, and with the later Latin works, we find that Swedenborg refers less and less to the biblical accounts, and in the beginning of the second Principia the absence of reference to the Genesis account is very striking. He evidently becamelesa and less literal as he abstracted his philosophy from its first matrix, al-though remaining a devout believer in the Deity (Numen), identical with the Infinite of the Principia. In his later theological works the accounts in Genesis are continually referred to as being not literally, but spiritually, true. In his Latin Principia Swedenborg had already so far separated him-self from the Lutheran theology that his De Infinito, 1734, was criticized as being materialistic, which it certainly is not; and that there must have been a very considerable freedom in Sweden with regard to such questions would seem to be indicated by the faet that the De Infinito was dedicated to Eric Benzelius, who had become Bishop of Linköping and who later became Archbishop of the Swedish Church. The Roman Church was, however, less complacent and honored the Principia of 1734 by placing in on the Index Expurgatorius.

The Texts and Translations.

The texts of the Prodromus and other short treatises1-227 were published at Amsterdam in 1721, and the Index140 shows that they were all in hand and possibly in the press at the same time. No trace has ever been found of the Principia referred to in the Prodromus, although it seems certain from the references that Swedenborg had actually committed it to writing, or at least drafted it. The Principia references of the Prodromus evidently have no connection with the second Principia, as some have sup-posed. (See R. L. Tafel's Documents concerning Swedenborg, London, 1875 —1877, Vol. IL, p. 899). In a monumental work published in 1906 by the late Rev. James Hyde, A Bibliography of the Works of Emanuel Swedenborg London, 1906, the second Principia is still dated 1720 (p. 32). But immediately after the publication of An Abridged Chronological List of the Works of Emanuel Swedenborg, Stockholm, 1910, I had an opportunity of thoroughly discussing this question with Mr. Hyde, when we agreed that the true date is mueh later, probably about 1729. The evidence for this is contained in Sweden-borg's letter to Anders Celsius, the secretary of the Royal Society of Sciences of Upsala, (Vol. L, p. 321).

Swedenborg's reference to »ex priori et posteriori principia Naturae» reminds one strongly of the title of the second Principia, and the reference to magnetism indicates that the questions treated of in Part II. and other portions of the »Principia» of 1734 were in the author's mind as early as 1429.Several of the short Latin treatises published simultaneously with the Prodromus had previously appeared in Sweden in the Swedish language, and were in their Latin dress reproductions and extensions of the Swedish originals. (See the Chronological List, Stockholm, 1910, which will appear in extended form in the Appendix to Vol. I. of this series and will contain not only references to all printed editions of Swedenborgs texts, but also to the numerous facsimile reproductions of MSS. published at Stockholm, 1869—70, and subsequently.)

The manuscript of De Causis Rerum is preserved in the »Benzelius Collec-tion* of the Linköping Diocesan Library, Codex 14 A, No. 30, and in the same volume No. 43 is preserved the manuscript of Om eldens ocli fergornas natur.

The manuscript of the Discours emellan Meclianiguen och Chymien om naturens icäsende is preserved in the Royal Library, Stockholm, among the manu-scripts of Polhem, where it was found by the editor in 1903.

The manuscript of Philosophia corpuscularis in compendio is contained in Swedenborg's MS., Codex 57, preserved in the Library of the Royal Swedish Academy of Sciences, Stockholm.

The manuscript of En ny theorie om jordens afstannande is preserved in the »Benzelius Collection» of the Linköping Diocesan Library, Codex 14 A, No. 34.

The manuscript of En ny mening om jordens och planeternas Gång och Stånd eller några Beivis at jorden löper alt sachtare och sachtare: at winter och sommar, dagar och dygn til tiden blifwa lengre och lengre in til werldsens sista tid, is in the possession of Jarl Ernberg, Esq., Stockholm, and has been in his family for many years, having originally come into its possession through Secretary Von Kocken, an official of the time of Charles XII.

The little Swedish work J. N. D: Om jordenes och planeternas Gång

och Stånd: thet är några Bewisliga skiäl at Jorden aftager i sitt lopp och nu

går långsammare än tillförene: giörande winter och sommar, dagar och nätter lengre

i anseende till tiden nu än förr, appeared at Skara in 1718 and is evidently the final form in which Swedenborg produced his work on the »Earth and Planets», the two manuscript preparations for which are printed on pages 269.—298.

In conclusion, the attention of the reader is especially directed to the

Appendix to Vol. I. of this series in which the revised Chronological List of Sivedenborg's Works is to appear, together with other information respecting the manuscripts and printed works of Swedenborg. In the final volume of the series the Notae Criticae for the texts and other critical matter will appear, together with an Index.kA'./w .ISPllI -

•\ r-T®‘? i.-; ; v

<4

i-.';•*•:* V-rf.

KS*?

- 4^*

V-'V-vV^.

p 4rS

i* r,-y

V j/v . VÅ"

Series 9482

-.. •; v .- ,. • v* • •

’ -r*>

>r-4,-r

•vitii

/